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PREFACE.

To prevent misapprehension or disappointment on the part of the Reader, I think it necessary to offer a short account of the nature and object of the following Outlines.

During the thirteen years I have had the honour of delivering Lectures upon Anatomy and Surgery in the University of Edinburgh, I have been repeatedly and earnestly entreated by the Students attending my Class, to publish an abstract of my Course.

I considered it a duty to comply with their request; and the volumes now offered to the world, exhibit the subjects which are explained at large in the progress of a session of six months duration.

The Outlines have been arranged differently from any Treatise with which I am acquainted, and upon a plan which has been sanctioned by the experience nearly of a century, having been adopted by my Grandfather, and observed since his death by my Father and myself.

Though, from the titles of these volumes, they may be supposed to relate to the Anatomy of the Human Body only, in its sound and diseased state; yet, as Physiology is inseparable from Anatomy, it seemed impossible to avoid introducing a few notices on that subject, and also on Animal Chemistry.

The chemical part of these Outlines merits the particular attention of the reader, as it contains much original matter,—the result of the researches of my very worthy friend and pupil Mr John Davy, who, to great assiduity and enthusiasm for the advancement of chemical science, joins that patience and that acumen, which so much distinguish his family.

The descriptions of the bones, occupying the greater part of the First Volume, have been ta-

ken from my grandfather's "*Osteology*;"—a book which is now ranked as one of the classics in Anatomical Science, and though published nearly a century ago, still retains its celebrity.

It may not, however, be improper to remark, that, in reprinting the "Osteology," I was under the necessity of making several alterations and additions, and especially in the Physiological and Pathological departments; on which the public may not be disposed to place the less value, when it is stated, that, independently of those suggested by my own experience and observation, and the present advanced state of Anatomical Science, many of them were derived from an original Commentary, written by my Grandfather for the use of his sons, and from the lectures of my Father.

Descriptions in language, however carefully drawn up, being inadequate to convey distinct ideas on many points of Anatomy, a number of engravings from the drawings of the most celebrated draughtsmen, MICHAEL ANGELO BUONAROTTI, Dr P. CAMPER, Messrs FYFE, LIZARS and SYME, are affixed to these Outlines.

The greater number of these engravings represent the effects of disease, and have been copied from the more remarkable specimens in the large and valuable collection of morbid Preparations in the UNIVERSITY OF EDINBURGH; and where colour constitutes a striking feature, it is added, that the Plates may be more faithful representations of nature. Some of the Plates are fac similes of the drawings; by which a much more correct imitation of the drawings is preserved, than if they had been executed in a more laboured style; and as information, not beauty, has been consulted, this fidelity of representation seemed best calculated to convey it.

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For the benefit of advanced students, who may wish to extend and generalize their knowledge by the aid of books, a List of the more distinguished Authors on the several branches of Anatomy is subjoined.

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PART I.

OUTLINES

OF THE

ANATOMY OF THE HUMAN BODY.

THE word *Anatomy*, strictly interpreted, implies merely dissection; but it is commonly taken in a more general signification, as comprehending that science, by which, through the medium of dissection, we become acquainted with the structure, mechanism, disposition, and uses of the several parts which enter into the composition of the bodies of animals.

This science comprehends the Anatomy of the Human Body, and the Anatomy of Animals; the points of similarity, or dissimilarity, observed in their organization, constituting Comparative Anatomy.

In this book, it is proposed to introduce only as much of Comparative Anatomy, as tends to throw light on the structure or uses of the several parts of the Human Body.

CHAPTER I.

GENERAL OBSERVATIONS ON THE COMPOSITION OF THE HUMAN BODY.

The human body is composed of *Solids* and *Fluids*, which may be separated from one another by various means, as by exsiccation, or expression.

The solids have been arranged under two classes; the *hard* and *soft*. Under the first class, the Bones and Cartilages are included; and under the second, the Muscles, Viscera, Nerves, and all the other parts.

The solids, when mechanically divided, are found to consist of Layers, Fibres, and Filaments.

Cellular substance, or *cellulosity*, envelopes, pervades, and seems to form the basis of the denser parts. In membranes there is a good deal of compact, or condensed, cellular substance; and the Vessels are membranes, rounded into cylinders, with the addition of muscular fibres.

Thick, strong and elastic membranes, have been called Ligaments.

An elastic jelly, added to cellular membrane, constitutes Cartilage.

Jelly and phosphate of lime, with cellular substance, form the principal ingredients of Bone.

Muscles consist of fibres of a peculiar nature, and of cellular membrane.

The bodies of animals are assemblages of organs, each of which exercises some function, and is conducive to the preservation of the whole. The different organs are of a more simple or complicated structure, being made up of different *tissues*, as they have been called by Bichat.

Bichat has enumerated twenty-one tissues*, which he has shewn to be differently organized; and has justly remarked, "L'idée de considérer ainsi abstractivement les différens tissus simples de nos parties, n'est point une conception imaginaire; elle repose sur les fondemens les plus réels, et je crois qu'elle aura sur la physiologie,

* "Ces tissus sont 1. le cellulaire, 2. le nerveux de la vie animale, 3. le nerveux de la vie organique, 4. l'artériel, 5. le veineux, 6. celui des exhalans, 7. celui des absorbans et de leurs glandes, 8. l'osseux, 9. le médullaire, 10. le cartilagineux, 11. le fibreux, 12. le fibro-cartilagineux, 13. le musculaire de la vie animale, 14. le musculaire de la vie organique, 15. le muqueux, 16. le séreux, 17. le synovial, 18. le glanduleux, 19. le dermoïde, 20. l'épidermoïde, 21. le pileux." *Vid.* Anatomie Generale, tome i.

comme sur la pratique médicale, une puissante influence. En effet quel que soit le point de vue sous lequel on considère ces tissus, ils ne se ressemblent nullement. C'est la nature, et non la science, qui a tiré une ligne de démarcation entr'eux."

These tissues, in whatever part of the body they are situated, exhibit the same physical properties; and, further, each particular tissue is subject to peculiar organic derangements *.

Anatomy, so far as it considers the solids, has been divided into various branches, distinguished by different names, of Greek etymology, expressive of the parts referred to; as,

Osteology, ... A Description of the Bones.
Syndesmology, . . Of the Ligaments.
Myology, ... Of the Muscles.
Splanchnology, . . Of the Bowels.
Adenology, ... Of the Glands.

* From the remarkable coincidence in the sentiments, and in many of the passages of Dr Carmichael Smyth's paper on Inflammation, published in the 2d volume of the London Medical Communications, and in Bichat's Traité des Membranes, and in his Anatomie Générale, I cannot but think that Dr C. Smyth was the author of the New System, which has prepared the way to a more minute, accurate, and philosophical examination of the structure and properties of our different organs; and which has tended so much to the advancement of physiological and pathological science, which now indeed has assumed a new aspect.

ANGIOLOGY, ... Of the structure and course of the Blood-vessels.

NEUROLOGY, ... Of the Nerves.

It is not easy to detect the chemical ingredients which enter into the composition of the body;

1. As new compounds are formed during the processes instituted for that purpose.

2. As many of the constituent principles are apt to escape in a gaseous state, or to elude observation.

According to the present state of Animal Chemistry, Carbon, Azote, Hydrogen, Oxygen, Sulphur, and a small proportion of Iron, are supposed to form the constituent elements of the animal body, producing Jelly, Albumen, and Fibrina.

CHAPTER II.

ORGANS OF LOCOMOTION.

THE organs of the body concerned in locomotion, are, the Bones, Cartilages, Ligaments, Muscles, Tendons, and Bursæ Mucosæ.

Sect. I.

BONES OF THE ADULT.

General Observations on the Bones of the Adult.

The bones, are of a white, light yellow, or light brown colour, and opaque. In the healthy state, they are hard, compact, inflexible, insensible, and when dried do not change their figure.

The bones are covered by a membrane, named, on that account, *Periosteum*, to which the word *Externum* is added, to distinguish it from a membrane which lines the bones, called *Periosteum Internum*.

The internal periosteum is much thinner than the external. The processes of this membrane enter into the transverse pores of the bones, where probably they are continued, to support the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external periosteum, into the bone *. These processes being of a very delicate texture, the adhesion of this membrane to the bone is so small, that it commonly separates more easily from the bone than from the marrow contained in the bone.

The bones when united together in their natural order, by the ligaments, form what is called

* Winslow, Exposition anat. des Os frais, § 82, 83.

a *natural skeleton;* and when united by wires, an *artificial skeleton.*

In the animal kingdom, there is much variety in the form of the skeleton, and disposition of its component parts.

In many animals, the skeleton is *external,* forming a fixed basis on which the muscles act, and also a case within which the animal retreats.

The human skeleton, on the contrary, is *internal,* that is, covered by soft parts; but though thus covered, the bones appear obscurely through many of the superincumbent parts, so as to form the outline, and to give a certain character to the body.

There is a difference in regard to the size of the bones of the skeleton, in different individuals even of the same age, of the same sex, and of the same country; and a still more striking variety at different periods of life, in the different sexes, and among the inhabitants of different countries.

Purposes to which the Skeleton is subservient.

1. The skeleton is the foundation on which the whole fabric is built. It is the basis to which all the other parts are directly or indirectly connected, and to these it gives stability and support.

2. The bones defend from external injury the brain, heart, lungs, and other organs, on which life more immediately depends; and also many of the larger bloodvessels and nerves.

3. The skeleton determines the size, figure, position, proportion, and motions of the several members of the body, and regulates its attitudes.

4. The skeleton forms an essential part of the organs of locomotion, being an immoveable fulcrum for the action of the muscles and their tendons, without which they could not act; hence when the bones are rendered soft by disease, we lose the power of locomotion.

The bones of the spine and extremities of the body, form solid, though flexible columns, capable of being moved in various directions.

5. The extremities of the bones give form to the joints; and this connection has been termed their *articulation.*

The increased volume of the extremities of the bones, tends to render the jointsmore secure,—is conducive to the symmetry of the limbs, the bellies of the muscles being attached to the middle parts of the bones, and the tendons to their protuberances,—increases the force of the muscles which bend and extend the members,—prevents the risk of attrition, laceration, or compression of those muscles or their tendons, which are necessary for the motion of the joint,—and protects from injury or pressure, during our sudden movements, or changes of curvature, the bloodvessels and nerves in the vicinity of the moveable joints.

By studying the form of the bones of the joints, we may discover what particular motion is performed by that joint; there being an exact re-

lation betwen the joint, and the muscles which move it; thus, there is ball and socket for admitting of free motion in every direction; hinge-joints, where flexion and extension only are necessary; and these joints are more or less secure in different parts of the body; thus, the socket at the hip-joint is much deeper than at the shoulder, as the inferior extremities are subservient not to locomotion only, but also to the support of the body.

6. The bones of the skeleton are said to be disposed symmetrically, by which it is meant to be implied, that there is an exact correspondency of the opposite sides; for by a vertical plane from before, backward, the skeleton may be divided into two equal and similar parts. But the above observation should be received with some limitation, for in many instances the opposite bones are not exactly similar to each other, and in many cases one bone inclines more to one side than the other corresponding to it.

7. From the position of the skull and pelvis, from the width of the latter, the disproportion in the length of the superior and inferior extremities, and the very different structure of the joints of these parts, it is evident that man is intended to be a biped.

8. The bones of the human skeleton are so placed with respect to one another, that, when put into their natural situation, scarcely any one of them is placed in a perpendicular bearing to an-

other; though the fabric composed of them is so contrived, that, in an erect posture, a perpendicular line, from their common centre of gravity, falls in the middle of their common base *. On this account, we can support ourselves as firmly, as if the axis of all the bones had been a straight line perpendicular to the horizon; and we have much greater quickness, ease, and strength in several of the most necessary motions we perform. It is true indeed, that wherever the bones, on which any part of our body is sustained, decline from a straight line, the force required in the muscles, to counteract the gravity of that part, is greater than otherwise it needed to have been: But then this is effectually provided for in such places, by the number and strength of the muscles. So long therefore as we remain in the same posture, a considerable number of muscles must be in a constant state of contraction; which we know, both from reason and experience, must soon create an uneasy sensation. This we call, being weary of one posture; an inconvenience that we should not have had in standing erect, if the bearing of all the bones to each other had been perpendicular; but this is more than compensated by the advantages above mentioned.

9. The disposition of the bones, and their form have a reference to the function of the part with which they are connected. Hence the Brain and Spinal Marrow, which are very important organs,

* Cowper, Anat. of Human Bodies, explic. of tab. 87, 88.

of a delicate fabric, and impatient of pressure, are contained within a bony case.—The form of the teeth and jaws, indicates the kind of food on which the animal subsists.—The senses of smell, hearing, tasting, and seeing, are much improved by the peculiar form of the bones.—The Ribs protect the organs they inclose; and their oblique position in respect to the spine, has a reference to the enlargement of the chest, during inspiration; for when the ribs are brought to a right angle with the spine, the breast-bone is pushed forwards, and the distance between the fore and back part of the chest is increased.—The Pelvis is of such a shape, as to contain and defend many important parts, and is so formed before, that the adjacent muscles act upon the hollow bowels included within it.

10. Lastly, broad bones are placed where defence is necessary, or where considerable space is required for the attachment of powerful muscles;—long bones where extensive motion is performed;—and short bones, where it is requisite to unite a certain degree of firmness with mobility.

Table

Table of the Bones of the SKELETON *of the Adult, exhibiting the divisions, names, and the number of bones which compose it.*

THE bones of the SKELETON have been generally divided into three classes, viz. the bones of the *HEAD*, those of the *TRUNK*, and those of the *EXTREMITIES*.

The bones proper to the *HEAD* have been arranged by anatomists, into those proper to the *Cranium*, and those of the *Face*.

The bones of the CRANIUM are,

1 or 2 Ossa Frontis.
2 Ossa Parietalia.
2 Ossa Temporum.
1 Os Occipitis.
Os Sphenoides,—which in the adult is joined to the preceding bone.
2 Mallei.
2 Incudes.
2 Stapedes.
2 Ossa Orbicularia.
1 Os Ethmoides.

The bones of the FACE are,

2 Ossa Maxillaria Superiora.
1 Maxilla Inferior.
2 Ossa Malarum
2 Ossa Nasi.
2 Ossa Unguis.
2 Ossa Palati.
2 Ossa Turbinata.

2 Ossa Triangularia.
1 Vomer.
32 Teeth.

The bones which support the TONGUE, are 5 in number.

The bones of the *TRUNK of the Body*, are subdivided into those of the *Spine*, *Thorax*, and *Pelvis*.

The bones of the SPINE and THORAX, are,

7 Vertebræ of the Neck.
12 Vertebræ of the Back.
5 Vertebræ of the Loins.
24 Ribs.
2 or 3 Bones compose the Breast-Bone or Sternum.

The bones of the PELVIS are,

2 Ossa Innominata *.
1 Os Sacrum.
4 Ossa Coccygis.

The bones of the *EXTREMITIES* are subdivided into those of the *Upper*, and into those of the *Under Extremity*.

The Bones of the UPPER EXTREMITY are made up of the bones of the *Shoulders*, *Arms*, *Fore-Arms*, and *Hands*.

The bones of the SHOULDERS are,

2 Clavicles.
2 Scapulæ.

* These bones have been enumerated by some authors among the bones of the Inferior Extremities.

Bones of the ARMS,
2 Humeri.

Of the FORE-ARMS,
2 Ulnæ.
2 Radii.

Those of the HANDS, include the bones of the *Carpi, Metacarpi,* and *Fingers.*

Bones of the CARPI,
2 Scaphoides.
2 Lunaria.
2 Cuneiformia.
2 Pisiformia.
2 Trapezia.
2 Trapezoides.
2 Magna.
2 Unciformia.

Of the METACARPI,
10 Ossa Metacarpi.

Of the FINGERS,
10 Posterior Phalanges.
8 Middle Phalanges.
10 Anterior Phalanges Unguium.

From 4 to 6 OSSA SESAMOIDEA.

The bones of the INFERIOR EXTREMITIES have been subdivided into three classes; into the bones of the *Thighs, Legs,* and *Feet.*

Of the THIGHS,
2 Ossa Femorum.

Of the LEGS,
2 Tibiæ.
2 Fibulæ.
2 Patellæ.

The bones of the FEET have been subdivided into the bones of the *Tarsi*, *Metatarsi*, and *Toes*.

The bones of the TARSI are,

2 Astragali.
2 Ossa Calcis.
2 Ossa Navicularia.
2 Ossa Cuboidea.
2 Cuneiformia externa.
2 Cuneiformia media.
2 Cuneiformia interna.

Of the METATARSI,

10 Ossa Metatarsi.

Of the FEET,

10 Posterior Phalanges.
8 Middle Phalanges.
10 Anterior Phalanges.

The number of the SESAMOID BONES of the Feet, varies from 4 to 8.

Varieties of the form, size, situation, and uses of the Bones.

THERE is a considerable difference with regard to the magnitude, figure, situation, connection, and uses of the bones.

The bones may be arranged under three classes, —the *broad*, the *cylindrical*, and those of an *irregular* figure.

Many bones have protuberances, or *processes* *, rising out of them. If a *process* stands out in a roundish ball, it is called *caput*, or *head*. If the head is flattened, it obtains the appellation of *condyle*. A rough unequal protuberance, is called *tuberosity*. When a *process* rises narrow, and then becomes large, the narrow or small part is named *cervix*, or *neck*. Long ridges of bones, are called *spines*. Such processes as terminate in a sharp point, have the general name of *coronæ* †, or *coronoid*, bestowed on them, though most of them receive particular names, from the resemblance they have, or are imagined to have, to other substances, *e. g. mastoid, styloid, anchoroid, coracoid, spinal, &c.* Such processes as form brims of cavities, are called *supercilia* ‡.

* Ἀπόφυσις, ἐκφυσις, ἐξοχὴ, προβολὴ, πρόβλημα, Excessus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enascentia.

† Rostra, glandes.

‡ Ὄφρυς, ὀφρύος, ἀμβονες, χειλη, Labra.

On the surfaces of a great many of the bones there are cavities, or depressions: If these are deep, with large brims, authors name them *cotylæ* *. If they are superficial, they obtain the designation of *glenæ*, or *glenoid*. These general *classes* are again divided into several *species:* Of which *pits* are small roundish channels, sunk perpendicularly into the bone; *furrows* are long narrow canals, formed in the surface; *niches*, or *notches*, small breaches in the bone; *sinuosities*, broad, but superficial depressions without brims; *fossæ*, large deep cavities, which are not equally surrounded by high brims; *sinuses*, large cavities within the substance of the bones, with small apertures; *foramina*, or holes, canals that pierce quite through the substance of the bones. When this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The eminences and hollows of the bones, which are more strongly marked in the male than in the female, give insertion to the muscles and ligaments, or form surfaces of articulation. By removing the insertions of the muscles farther from the axis of the bone, they increase their power of moving it.

The eminences to which the ligaments are fixed, remove the ligament to a greater distance

* Κοτυλίδες, ὀξυβάφοι, Acetabula, pixides, buccellæ.

from the centre of the joint, and thereby give greater security to it.

The cavities on the surfaces of the bones, (with the exception of the articular cavities,) are intended for the reception of the muscles, or for giving passage to their tendons; thus, the extent of the surface of the bone is increased, though not its bulk.

The cavities allow the heads of bones to play in them; lodge and defend other parts; and afford safe passage to vessels, muscles, &c.

The Articulations.

The ARTICULATIONS are most commonly divided into three classes, viz. *symphysis*, *synarthrosis*, and *diarthrosis*.

SYMPHYSIS, which properly signifies the concretion or growing together of parts, when used to express the articulations of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it most authors only denote the bones to be connected by some other substance; and as there are different substances which serve this purpose, therefore they divide it into the three following species:

1. *Synchondrosis* *, when a cartilage is the connecting substance: Thus the ribs are joined to

* Amphiarthrosis.

the sternum; the bodies of the vertebræ to each other; as are likewise the ossa pubis.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syssarcosis*, when muscles are stretched from one bone to another, without the intervention of cartilage or ligament.

The *second* class of articulations, the SYNARTHROSIS, which is the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds:

1. The *suture* *, is that articulation where two bones are mutually indented into each other, or as if they were sewed together, and is formed by the fibres of two bones meeting, while they are yet flexible and yielding, and have not come to their full extent of growth; so that they mutually force into the interstices of each other, till, meeting with such resistance as they are not able to overcome, they are stopped from sprouting out farther, or are reflected; and therefore these indentations are very different, both in figure and magnitude: Thus the bones of the head are joined; thus epiphyses are joined to the bones, before their full connection and union with them.

Under this title of *suture*, the *harmonia* of the

* Ῥαφή.

ancients may be comprehended; scarcely any unmoved bones being joined by plain surfaces *.

2. *Gomphosis* †, is the fixing one bone into another as a nail is fixed in a board: Thus the teeth are secured in their sockets.

3. *Schindylesis* or *ploughing* ‡, when a thin lamella of one bone is received into a long narrow furrow of another: Thus the processus azygos of the sphenoid, and the nasal process of the ethmoid bone, are received by the vomer.

The *third* class, or DIARTHROSIS §, is the articulation where the bones are so loosely connected as to allow large motion. This is subdivided into three kinds:

The first is *enarthrosis*, or the ball and socket, when a large head is received into a deep cavity; as the head of the os femoris is into the acetabulum coxendicis.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and scapula. These two species of diarthrosis allow motion to all sides.

The third is *ginglimus* ||, which properly signifies the hinge of a door or window; in it the parts of the bones mutually receive, and are re-

* Vesal. Observ. Fallop. Examen.

† Conclavatio.

‡ Keil, Anat. chap. 5. § 3.

§ Ἀπαρθρώσις, dearticulatio, abarticulatio.

|| Articulatio mutua.

ceived, and allow of motion two ways: Workmen call it *charnal.*

The ginglimus is generally divided into three kinds, to which some * give the names of *contiguous* †, *distant* ‡, and *compound* §.

The first kind of ginglimus is, when a bone has several protuberances and cavities, which answer to as many cavities and processes of the other bone with which it is articulated; as in the conjunction of the femur with the tibia.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the radius and ulna.

The last sort is, when a bone receives another, and is received by a third; as in the oblique processes of the vertebræ.

When I mention the *symphysis* or *synarthrosis*; or any species of them, I shall always understand them according to the explication already given of them. But though the preceding account of the *diarthrosis*, or articulation of moveable bones, has been almost universally received; yet, seeing it does not comprehend all the moveable articulations of the body, and one of its species does not answer to any notion we can have of the conjunc-

* Baker, Curs. osteolog. demonstr. 1.
† Proximus.
‡ Longus.
§ Compositus.

tion of two bones, I must beg leave to change the definitions and kinds of these joints.

I would call *diarthrosis* that conjunction of bones, whereby they are fitted for motion, being each covered with a smooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they really do perform; the motion being often confined or enlarged by some other cause not immediately depending on the frame of the two surfaces of the bones forming the particular joint which then is considered.

The first species of the diarthrosis, *viz.* the *enarthrosis* or ball and socket, I would define more generally than above:—That articulation where a round head of one bone is received into a cavity of another, and consequently, without some foreign impediment, is capable of motion to all sides. Examples of this kind are to be seen in the articulation of the thigh-bone and ossa innominata; Arm-bone and scalpula; astragalus and os naviculare; magnum of the wrist, with the scaphoides and lunare; the metacarpal and metatarsal bones with the first bones of the fingers and toes, &c.

The second sort, or the *arthrodia*, differing from the enarthrosis, in the preceding account, only in the cavity being more superficial, which makes no essential difference, especially as, in the recent subject, cartilages or ligaments supply the deficiency of bone, ought, in my opinion, to be called,

with VESALIUS *, that articulation of two bones adapted for motion, where it is not at first sight obvious which of the two has the head or cavity, or where they are joined by plain surfaces, or nearly so; such is the conjunction of the clavicle with the scapula; ossa cuneiformia with the os naviculare; metatarsal bones with the ossa cuneiformia, &c. From the nature of this sort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural situation, than is convenient or safe.

Ginglimus, I would reckon that articulation by the form of which the motion of the joined bones must be chiefly confined to two directions, which hinges of doors are.

The first species of this is the *trochoides*, when one bone turns on another, as a wheel does on its axis. Thus the first vertebra of the neck moves on the toothlike process of the second. This is the most proper kind of ginglimus.

The second species should be esteemed that articulation where several prominent and hollow surfaces of two bones move on each other, within the same common ligament; as in the knee, elbow, &c.

The third species, where two bones play upon each other, at more than one place, as in the join-

* De corp. human. fabrica, lib. 1. cap. 4.

ing of the vertebræ with each other, the ulna with the radius, and the tibia with the fibula.

The colour of the Bones.

The colour of the bones depends upon various circumstances, as age, sex, the food, and the disease which proved fatal.

The bones of the adult are nearly white, whereas those of a child are more of a bluish tint, from the quantity of cartilage which enters into their composition.

The bones of the Negro are whiter than those of the European. And it is well known to anatomists, that the bones of persons cut off by dropsy, and those which have been repeatedly washed by sea-water, and then exposed to the sun, are the whitest.

There are some substances which communicate to the bones of living animals, peculiar colours. The *Rubia tinctorum*, or madder, renders bones of a crimson colour, owing, as my ingenious colleague Dr RUTHERFORD discovered, to an elective attraction between the phosphat of lime of the bones, and the colouring principle of the madder *.

The bones of some animals are green, and of others black †.

* *Vid.* Blake's Thesis de Dentibus, p. 119. et seq.

† *Vid.* Blumenbach's Comparative Anatomy, by Lawrence.

The intimate structure of Bones.

Bones are composed of a great many *plates* *, each of which is made up of fibres united by smaller fibrils †; which being irregularly disposed, and interwoven with the other larger fibres, make a reticular work ‡.

This texture is plainly seen in the bones of fœtuses, which have not their parts closely compacted, and in the bones of adults, which have been burnt, long exposed to the weather, or whose composition has been made loose by diseases. The chinks which are generally made according to the direction of the larger fibres of bones that have undergone the action of fire, or of the weather, shew the greater strength of these than of the fibres which connect them.

The plates are said § to be firmly joined to each other by a great number of *claviculi*, or small bony processes, which, rising from the inner plates, pierce through some, and are fixed into the more external ones. Of these nails, four kinds, viz. the *perpendicular*, *oblique*, *headed*, and *crooked*, have been described: But in bones fitly prepared, I could see only numerous irregular processes rising out from the plates ||.

* Squamæ, bractæ, laminæ.

† Malpigh. Anat. plant. & oper. posthum.

‡ *Vide* Plate 1.

§ Gagliard. Anat. ossium. nov. invent. illustrat. cap. 1. obs. 2.

|| Malpigh. oper. posthum.

Bones are more or lesss cavernous internally. In some (*e. g.* middle thin part of the scapula and os ilium) the solid sides are brought so near, that little cavity can be seen; and in others (middle of os humeri. femoris, &c.) the cavities are so large, that such bones are generally esteemed to be hollow or fistular. But the internal spongy texture is evident in young animals; and some of it may be seen to remain in those of greatest age, when bones are cautiously opened, after they have been kept so long as to be free of the oil they contain, or after being burnt.

This spongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner: The plates are firmly joined about the middle of the bone; but as they are extended towards its ends, the more internal plates separate from the exterior, and stretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been sent off in the same way. Seeing the plates are thus constantly going off, the solid sides of the bones must become thinner. This is evident in many of them, where the solid sides of their middle are very thick, and the cancelli are scarcely observable; whereas, at the ends, where their diameter is greatest, the solid walls or sides are not thicker than paper, and the cancelli are numerous and large enough to fill up the whole space left between the sides.

These cancelli differ considerably in figure, number, and size; and communicate with each other. Some writers * minutely remark these different appearances of the cancelli, after they begin to separate from the plates; and from thence distinguish them into *wrinkled*, *perforated*, and *net-like*.

The cancelli sustain the marrow, and prevent it from being injured in violent motions, and in different postures, and from being compressed by the weight of the marrow above. The depressions between the fibres of the external plates of bones appear like so many furrows on their surface, by which the surface of contact, consequently the adhesion between it and the bones, is increased, and a greater number of vesssels is sent from it into the bone, than if it were a plain surface.

The *broad* bones have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses, of affording a large enough surface for the muscles to rise from, and move upon, and of defending sufficiently the parts which they inclose.

The *round* bones have thick strong walls in the middle, and become very thin towards their ends, which is owing to very few plates separating at their middle; where, on that account, the cancelli

* Gagliard. Anat. ossium, cap. 1. obs. 4, 5, 6, 7.

are so fine and small, that they are not taken notice of.

Towards their ends, the lattice-work becomes very thick, and rather more complete than in the other sort of bones.

These round bones having strong forces naturally applied to them, and being otherwise exposed to violent injuries, have need of a cylindrical figure to resist external pressure, and of a considerable quantity of oil to preserve them from becoming too brittle.

Besides which, they are advantageously provided with thick sides towards their middle, where the greatest forces are applied to injure them; while their hollowness increases their diameter, and consequently, their strength to resist forces applied to break them transversely *. Thus, for instance, in estimating the proportional resistance of two cylindrical bones of unequal diameters, but consisting of an equal number of similar fibres uniformly disposed round each, it is plain,

1. That the absolute force of these two bones is equal, because they consist of equal numbers of similar fibres.

2. That the absolute forces of all the fibres in each bone, have the same effect in resisting any power applied to bend and to break them, as if the sum of all their forces were united in the respective centres of the transverse sections, where the fractures are

* Galilei Mechanic. dialog. 2.

to be made. For, by hypothesis, the fibres being uniformly disposed in each, there is not any fibre in either bone that has not a corresponding fibre; the sum of both, whose distances from the axis of revolution (about which all the parts of the bone must revolve in breaking) is equal to two semidiameters of the bone: Consequently each fibre, and all the fibres, may be regarded as resisting at the distance of one semidiameter or radius from this axis, that is, in the centre.

3. Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semidiameter, it follows, that the total resistance of all these fibres, or the strength of the bone, is proportional to its semidiameter, and consequently to its diameter.

I have here taken for an example, one of the most simple cases for calculating the proportional forces of bones. But, were it not too foreign to the present design, it might be universally demonstrated, that, of whatever figure bones are, and in whatever manner their fibres are disposed, their strength must always be in a ratio, compounded of the area of their transverse sections, or of their quantity of bony matter, and of the distance of the centre of gravity of these sections, from the centre of motion or fulcrum, on which the bone is supposed to turn when broken *.

* See the demonstration of this theorem by Dr Porterfield in the Edinburgh Medical Essays, vol. 1. art. 10.

Since, therefore, the strength of bones depends on their number of fibres, or quantity of matter, and the largeness of their diameters, one may conclude, that the part of a bone formerly fractured, and reunited by a callus, must be stronger than it was before the fracture happened; because both these advantages are obtained by a callus; which is a wise provision, since bones are never set in such a good direction as they were naturally of. This callus may indeed, for want of compression, be allowed to form into a spongy cellular substance; but even in this case, the strength of the bone is here increased by one or both the causes above mentioned.

It may not be improper to add, that although the hollowness of a bone enables it to resist better such forces as are applied to break it transversely, because the corresponding fibres are at a greater distance from the immoveable centre on which they turn, and therefore resist more, from their gaining the advantage of a longer lever; yet we are to observe, that where a bone is pressed in, as by the wheel of a cart, or beat in by the stroke of a stone, or of a bullet, its resistance is lessened by its hollowness, because the impelling force acts with the advantage of a longer lever. Thus, a small glass phial is perhaps strong enough to support a man's weight, but a larger phial of the same thickness will be broken by it. Hence also, if two skulls be of the same thickness, but

unequal in size, the larger is more readily fractured.

Of the Marrow.

The marrow, which differs in appearance in different bones, is secreted by the small arteries.

Pure marrow, according to BERZELIUS *, is a species of fixed oil, possessing peculiar properties, and somewhat like butter, consisting of the following ingredients:

Pure marrow,	0.96
Skins and bloodvessels,	0.01
Albumen, Gelatine, Extractive, Peculiar matter,	0.03
Water,	1.00

There is at least one considerable artery for each bone; several bones have more, whose principal use is to convey and secern this oily matter. After these arteries have pierced the solid side of a bone, they are divided into several branches; which soon are distributed every where on the internal periosteum, and afterwards spread their branches inwards on the medullary cells, and outwards through the tables of the bone.

The blood, which remains after the secretion of

* *Vide* Gehlen's Journal, 2d series.

the marrow, is returned by proper veins, which are collected from the membranes into one or two large trunks, to pass out at the same holes or passages at which the artery or arteries enter.

By experiments made on the marrow, when bones of living animals are opened or cut through *, and from the racking pain with which suppurations within bones are frequently attended, we have sufficient proof that the membranes here are sensible, and consequently have nerves distributed to them. HIPPOCRATES † might therefore say justly, that a wound penetrating into the cavity of a bone may produce a delirium.

On the internal surface of the solid parts of bones, there are orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other *transverse* passages go out to terminate in other *longitudinal* canals; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller gradually as they approach the outer surface ‡. These canals are to be seen to the best advantage in a bone burnt till it is white: When it is broken transversely, the orifices of the longitudinal canals are in view; and when we separate the plates, the transverse ones are to be observed.

* Du Verney, Memoires de l'acad. des sciences, 1709.

† Aphorism. § 7. aph. 24.

‡ Haver's Osteolog. nov. p. 43.

We see marrow contained in the larger transverse and longitudinal canals, and thence judge that it passes also into the smaller ones.

The drops of oil which we discover with a microscope every where on the surface of a recent bone fractured transversely, and the oozing of oil through the most solid bones of a skeleton, which renders them greasy and yellow, are a confirmation of the use of these canals.

Most bones have also one or more large oblique canals formed through their sides for the passage of the medullary vessels.

Chemical Analysis of Bones.

The component parts of bone are Earth, Jelly, Cartilage, and Oil.

These constituent principles may be separated in different ways,—by burning bones in a fire,—by acids,—and by boiling.

By the aid of fire, the animal matter is driven off; and by the addition of acids, the earthy matter is dissolved, and may be readily precipitated.

The earthy matter contained in human bones consists of the Phosphate of Lime, of Carbonate of Lime, and of a very small proportion of the Sulphate of Lime.

In the bones of quadrupeds, a small proportion of the Phosphate of Magnesia has also been detected by FOURCROY and VAUQUELIN.

The oil and jelly of the bones may be readily obtained by boiling bones; the former swims on the surface, and the water dissolves the jelly.

When bones have been boiled for some time, and deprived of their jelly, and of their earthy matter by being immersed in an acid, a soft greyish-coloured cartilage remains, retaining the figure of the bone, which, according to Mr HATCHETT *, the discoverer of this substance in bones, is similar in its properties to coagulated albumen.

Several of the modern chemists have analysed bones, more especially Mr HATCHETT, FOURCROY, VAUQUELIN, CADET DE VAUX, and MERAT GUILLOT; but their researches have been limited chiefly to the examination of the bones of quadrupeds, and few experiments have been made upon human bones, either in their sound or diseased state. In these circumstances, I requested of my friend and pupil Mr JOHN DAVY, whose chemical knowledge is well known to the public, to analyse the bones of persons of different ages, in their sound and diseased state; with which request he readily complied, and has favoured me with the following results:

"I have carefully examined the different specimens of bones you gave me. The experiments I have made on them were few, want of leisure not allowing me to be minute. I have tried them respectively with dilute muriatic acid, and have

* Vid. Lond. Phil. Trans.

found all of them similarly acted on. They effervesced slightly; yielded a cartilaginous residue, and their solutions afforded a precipitate with ammonia. The only apparent difference was in respect to the degree of effervescence. The reticular bones effervesced more briskly than the firm and compact ones. But this appeared to be principally owing to the greater extent of surface exposed to the acid by the former, than by the latter; for I obtained from 50 grains of the rickety parietal bone 2 grains of carbonate of lime, just the proportion found by Mr Pepys in human teeth.

"I have only attempted to ascertain the proportions of earth and of animal matter. To effect this, I exposed a certain quantity of each bone separately, in an open crucible, to a red heat, till it was rendered white, or perfectly free from carbonaceous matter, internally as well as externally. For the sake of greater accuracy, the pieces of bones made the subjects of experiment were loosely wrapped up in a thin sheet of platina. Thus the admixture of dust from the fire was excluded.

"I shall give the results in the following tables:—

1. *Human Bones apparently in a Sound State.*

100 Parts consist of	Animal matter.	Earth.
Pars petrosa of the temporal bone of an adult, - -	33.3	66.7
Temporal bone of the same under the zygomatic process, -	34.7	65.3
Occipital bone of the same, -	40.0	60.0
A part of the lower jaw of the same, between the symphysis and processes,	40.5	59.5
The parietal bone of another adult,	35.6	64.4
Another parietal bone of an adult,	37.5	62.5
The body of the tibia of an adult,	36.0	64.0
The body of the thigh-bone of an adult,	37.5	62.5
The occipital bone of an old man,	31.0	69
A part of the lower jaw of an old person, between the symphysis and processes; the alveoli were absorbed; the bone brittle, - -	43.4	56.6
Lower jaw of a child, - -	42.8	57.2
The occipital bone of a Negro; very hard, compact and white, -	40.5	59.5

1.—*Continued.*

100 Parts consist of	Animal matter.	Earth.
The occipital bone of another adult Negro, hard, compact and white, but not in so great a degree as the former, - - -	41.1	58.9
Occipital bone of a subject of about fifteen years of age, of the usual appearance, - - -	42	58
Frontal bone of the same subject,	41.1	58.9
Parietal bone of the same subject,	41.2	58.8
Tibia of the same subject, -	46.4	53.6
Fibula of the same subject, -	56	44
Os Ilium of the same subject, -	55	45
Thigh-bone of the same subject,	53	47
Frontal bone of a child, the bregma still remaining, - - -	45.5	54.5
Parietal bone of the same skull, -	46	54

2. *Human Bones in a Diseased State.*

100 Parts consist of	Animal matter.	Earth.
The body of a large thigh-bone of an adult affected by hyperostosis; very thick and hard, but not very compact, *(vid. Plate* 2.), - -	23.1	76.9
The bone of a person who died of lues venerea; thick, light and spongy in a slight degree, - -	29.26	70.74
Cancelli of a curved tibia, -	25.5	74.5
The compact body of the same bone,	37.0	63.3
A rickety parietal bone, about an inch thick, *(vid. Plate* 3.), - -	27.1	72.9
Another portion of the same bone, similar in appearance, - -	30.5	69.5
The body of a rickety thigh-bone; very thick, - - - - -	37.8	62.2
An exostosis, - - - -	36.2	63.8
A scrofulous exostosis, *(vid. Plate* 4.),	37.0	63.0
A spinal process of a lumbar vertebra of the curved spine of a rickety person, - - - - -	40.7	59.3
A rib of the same person, -	40.8	59.2

2.—*Continued.*

100 Parts consist of	Animal matter.	Earth.
The tibia of a rickety child; soft and spongy, - - - -	74.0	26.0
A deformed female pelvis; soft and porous, and not unlike horn in appearance, - - - - -	75.8	24.2
Portion of bone cast off in the disease called Necrosis ossium, - -	40.8	59.2

3. *Fossil Bones, and Bones of different Animals.*

100 Parts consist of	Animal matter.	Earth.
Frontal Roman bone found at Pompeia; thick, and not unlike the rickety parietal bone, - - -	35.5	64.5
Bone found at Borrowstounness included in sandstone; apparently a human tibia, - - - - -	16.8	83.2
Bone from the banks of Ohio, reddened by oxide of iron, and penetrated by extraneous earthy matter, -	31	69

3.—*Continued.*

100 Parts consist of	Animal matter.	Earth.
A tooth of the mammoth, -	30.5	69.5
The enamel of the same tooth, -	17.4	82.6
Pars petrosa of the temporal bone of a whale, - - - -	27.4	72.6
Pars petrosa of the temporal bone of an elephant, - - - -	30.0	70.0
The perpendicular lamellæ of the vertebra of the large animal found on the shore of the Island of Stronsa*,	44.5	55.5
The internal cellular lamellar part of the same, penetrated by small foramina, - - - -	52.1	47.9
The fibrous part of the texture, having the appearance of willow, forming the cavity of the same vertebra, -	60.0	40.0

Observations.

" The loss which the different bones sustained by calcination, is considered as the proportion of animal matter entering into their composition.

* Vid. Description of this Animal, Memoirs of the Wernerian Natural History Society, vol. i.

This method of forming the estimate, though not perfectly accurate, is yet certainly near the truth, and apparently well adapted for comparative purposes.

" The results contained in the different tables vary so much, that they scarcely admit of any general conclusions to be drawn from them.

" Between the diseased bones there is the greatest difference of the proportions of the constituent parts. Some of the bones marked rickety, *contain more, and some less, earth, than the same bones in their healthy state,*—an additional proof, if further proof was wanting, that a deficiency of phosphate of lime is not an essential, but merely an adventitious circumstance in rickets.

" The results of the 1st Table shew, that the proportions of earth and of animal matter vary in different healthy bones of the same person, and in the similar bones of different persons ; that in old age, the phosphate of lime apparently increases in quantity in the occipital, and diminishes in the jaw bones; that the composition of the sequestra is much the same as that of sound bones ; and it further appears from these results, that the hardness of bones in general is not *always* proportional to the quantity of earth present, though in the same skeleton this probably is the case ; and lastly, the concordance of composition of two Negro skulls, both remarkably hard and white, renders it probable that the bones of Africans will be found to contain a larger pro-

portion of animal matter than the bones of Europeans.

" Respecting the bones placed in the table after the Negroes', it is necessary to observe, that they were examined but a day or two after they were taken from the subject to which they belonged, and had not been cleaned, as bones usually are that are designed to be preserved. There was consequently no deficiency of the animal *fluid* peculiar to them. This circumstance accounts for the much smaller proportion of earth in these than in the preceding sound bones. The bones of the lower extremity appeared to be saturated with this fluid; those of the head seemed almost entirely free from it; hence, too, the much smaller proportion of earth in the former than in the latter.

It is worthy of remark, that the fibrous part of the vertebra, in the last table, was very flexible, notwithstanding the considerable proportion of phosphat of lime present. It may be proper also to notice, that the enamel of the tooth of the mammoth was of singular hardness, sufficiently hard, indeed, to scratch glass; and yet, when deprived of its animal matter, of its cement, by calcination, it was more friable than any of the other bones. I endeavoured to ascertain if this enamel contained fluoric acid, but I could not detect its presence.

" To conclude: If the preceding results do not allow any general conclusion to be formed from them, they at least seem to shew that former in-

ferences were in some cases too hastily drawn, and that farther investigation of the subject is necessary."

Periosteum.

ALL the bones, except the boides of the teeth, are covered by a membrane, named on that account PERIOSTEUM *.

The *periosteum* can be divided into *layers* of fibres. The *exterior* ones, composed of the fibres of the muscles connected to the bones, vary in their number, size, and direction, and consequently occasion a very great difference in the thickness and strength of the periosteum of different bones, and even of the different parts of the same bone. The *internal* layer is every where nearly of a similar structure, and its fibres follow the same direction with those of the bone to which they are contiguous. Ought not then the name *periosteum* to be applied, strictly speaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

Except where muscles, cartilages, or ligaments are inserted into the periosteum, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but shorten themselves whenever the stretching force is removed.

When we attempt to tear off the periosteum from bones, we see a great number of white threads

* Membrana circumossalis, omentum ossibus impositum.

produced from the membrane into them; and, after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the periosteum *, but most of the fibres sent from tne membrane to the bone, shew themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the periosteum, the surface of the bone is almost covered with red points.

The veins corresponding to these arteries are sometimes to be seen in subjects that die with their vessels full of blood; though such numerous ramifications of them, as of the arteries, can seldom be demonstrated, because few of them naturally contain coloured liquors, and such liquors can with difficulty be injected into them. This however is sometimes done †.

The great sensibility of the periosteum in the deep-seated species of paronychia, in exostoses, nodi, tophi, and gummata, from a lues venerea, or whenever this membrane is in an inflamed state, is a sufficient proof that it is well provided with nerves, though they are perhaps too small to be traced upon it; and therefore one cannot well determine, whether they are sent along with the arteries in the common way, or are derived from the

* Ruysch. Epist. 5. tab. 5. fig. 1, 2.; Epist. 8. tab. 9. fig. 1. 9.

† See Traité d'osteologie, traduit de l'Anglois de Mr Monro. Note in page 9.

tendinous fibres of the muscles expanded on the periosteum *.

Vessels also pass through the periosteum to the marrow; of which more hereafter. And frequently muscles, ligaments, or cartilages, pierce through the periosteum, to be inserted into the bones.

The uses of the periosteum are:

1. To allow the muscles, when they contract or are stretched, to move and slide easily upon the bones; the smooth surface of this membrane preventing any ill effects of their friction upon each other.

2. To support the vessels in their passage to the bones.

3. To strengthen the conjunction of the bones with their epiphyses, ligaments, and cartilages, which are easily separated in young creatures, when this membrane is taken away.

4. To afford convenient origin and insertion to several muscles which are fixed to this membrane.

5. To assist in forming bone.

When the cellular substance connecting the periosteum to the surrounding parts is destroyed,

* See the dispute about the sensibility of this and of other membranes in Zimmerman. Dissert. de irritabilit.—Act. Gotting. vol. 2. Haller sur la nature sensible et irritable. Whytt's Physiolog. Essay II. Reimar. Dissert. de fungo articulor. § 26, 34.

these parts are fixed to that membrane, and lose the sliding motion they had upon it; as we see daily in issues, or any other tedious suppurations near a bone. When the vessels which go from the periosteum to the bones are broken or eroded, a collection of liquor is made between them, which produces a sordid ulcer, or rotten bone. This is often the case after fractures of bones, and inflammations of the periosteum, or after small-pox, measles, and erysipelas.

The Bloodvessels of Bones.

After a successful injection, the arteries of the bones may be traced in their course from the pits to the plates and fibres of the bones, by removing the earth of the bone, by putting it into the nitric or muriatic acid; and in sawing, cutting, or rasping the bones of a living animal, drops of blood are discharged even from the most solid parts of the bones.

That a great number of arteries enter into the composition of the bones, is obvious from the effect of madder given along with the food of an animal, which gradually communicates its tinge to every part of the bone.

The arteries are larger near each end than at the middle of the large bones, because they are not only distributed upon the bony plates near the ends, but pass through them to the marrow. As

animals advance in age, the arteries of the bones become less capacious; as is evident,

1. From the bones of adults having less blood in them than those of children have.

2. From many of them becoming incapable, in old age, of admitting the coloured powders used in injections, which easily pass in youth.

The arteries are accompanied with veins, which can sometimes be injected and then seen.

Lymphatic Vessels of Bones.

From what has been said of the vessels of bones, it is evident, that there is a constant circulation of fluids in every part of them; and that there is a perpetual waste and renewal of the particles which compose the solid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waste during the growth of the bones; the renewal and waste keeping pretty near *par* in adult middle age; and the waste exceeding the supply from the liquors in old age; as is demonstrable from their weight: For each bone increases in weight, as a person approaches to maturity; continues of nearly the same weight till old age begins, and then becomes lighter. The specific gravity of the solid sides, on the contrary, increases by age, for then they become more hard, compact and dense.

In consequence of this, the bones of old people are thinner and firmer in their sides, and have larger cavities than those of younger persons.

That lymphatic vessels are proper to bones, is obvious from the phenomena which take place during the formation of bone, from the red colour which is communicated to bones by feeding animals with madder, being removed, and from the effect of unnatural pressure on bones, and of remedies in removing their diseases.

The Nerves of the Bones.

Though it be impossible to demonstrate nerves within the bones, (the teeth excepted), yet it cannot be doubted that bones are extremely sensible.

The granulated flesh which sprouts from the bones after amputation, or after an exfoliation, is extremely sensible.

Ulceration of the bones is attended with very acute pain.

EXPLANATION OF PLATES.

Plate I.

This Engraving represents the layers of the middle of the human thigh-bone separated from each other, and also shews that the component layers of the bones are made up of fibres.

It may not be improper to add, that the preparation from which this engraving was taken, was prepared by my Father, and has been upwards of forty years in the Museum of the University.

Fœtal Bones.

The fœtal bones, which are much more numerous than those of the adult, exhibit a fibrous structure, more or less distinctly, in the interstices of which the bloodvessels are situated.

The fibres are formed upon membranes, as in the head; or within a jelly, as in the extremities of the body, and issue from centres of ossification. Upon examining with attention what takes place in the earlier stages of ossification, we observe small grains, deposited in an irregular manner, which are gradually united, so as to form fine fibres; which fibres are disposed differently in different bones, and become more numerous, and form a sort of network. The fibres are more numerous and more closely compacted towards the middle of the bones: hence a centre or centres of ossification have been described. New strata are added to the upper and under surfaces of the original stratum, and form the layers of the bones.

The process of ossification is by no means uniform as to its progress in the different bones of the skeleton: it is soonest completed in those bones which form the parietes of the cavities containing organs which are essential to life, and whose functions might have been interrupted by pres-

sure: hence the ribs are converted into bone at a very early period, in order that the weight of the superincumbent parts might not impede the action of the heart.

The ossification in the irregular-shaped bones, begins by a sort of nucleus, and in some such bones there are several nuclei of bone.

When the ossification has gone on a certain length, the fibres of the bones become less manifest, the interstices between the fibres being filled up by bony matter.

The long bones consist of three pieces, and in each piece there is a centre of ossification.

In the shaft of the bone, we observe at first a ring of bone, from which osseous fibres extend in a direction parallel to the axis of the bone.

To far the greater number of bones, whose ends are not joined to other bones by an immoveable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *Epiphyses*, or *Appendices* *. Some bones have one, others have two, three or four of these appendices annexed by the means of cartilages, which are of a considerable thickness in children, but by age become thinner; the ossification proceeding from the end of the bone on one side, and

* Applantatio, additamentum, adnascentia, adnexum, perone.

from the epiphyses on the other, till at last, in adults, the place of their conjunction can scarcely be seen on the external surface; and it is only sometimes that we can then see any mark of distinction in the cancelli *.

Several processes (*e.g.* trochanters of the thigh, spine of the scapula, &c.) have epiphyses; and processes frequently rise out from epiphyses; for example, at the lower end of the femur, ulna, tibia, &c †.

The epiphyses are united chiefly to such bones as are destined for frequent and violent motion; and for this purpose they are wisely framed of a larger diameter than the bone they belong to; thus the surface of contact between the two bones of any articulation being increased, their conjunction becomes firmer, and the muscles inserted into them act with greater force, by reason of their axes being further removed from the centre of motion. These advantages might indeed have been obtained by the expansion of the end of the bone itself, to a diameter equal to that of the epiphyses; but then the constant separation of new plates to form so wide a cellular structure, must have left the solid sides of the bones so thin, as to yield easily, either to the action of the muscles fixed to them, and passing over them, to the

* Winslow, Exposition Anatomique de Corps Humain, Traité des Os secs, § 116.

† Vesal. De Human. Corp. fabrica, lib. i. cap. 3.

weight several of them are obliged to support, or to the application of any other external force.

Of the Formation of Bone.

The most important circumstances respecting the formation of bone may be comprehended under the following heads.

1st, What is the nidus in which bone is deposited?

2d, Is bony matter contained in the blood; and whether this is deposited in a solid state, or held in solution, probably by an acid?

3d, What happens just before, and while the process is going on?

4th, Whether is bone derived from the vessels of the periosteum, or from those proper to the substance of the bones?

5th, At what time does the ossification of the different bones take place?

6th, Are there any causes which accelerate or retard the process of ossification?

What is the nidus in which Bone is formed?

According to Dr BOERHAAVE, when ossification is about to take place, the lymph of the blood is effused, which lymph has a determined shape, and is covered by a membrane.

According to Dr MACDONALD'S experiments, pure blood is effused between the broken ends of the

bone, from which the red globules are in a short time abstracted. This coagulated blood, or incipient callus, in a short time becomes vascular, and is covered by a new-formed periosteum, which adheres to the original periosteum, after which the process of ossification takes place. But so much violence was offered, and many of the arteries torn in breaking the bones, that Dr MACDONALD's experiments have not been supposed to be conclusive.

It has occurred to me, that, by examining the bones during their growth in the chronic form of hydrocephalus, we might determine whether lymph or blood be effused before bone is deposited; and in several such cases, I have seen the bony fibres, shooting towards the circumference of the bones in a red-coloured lymph.

Is Bone formed within Cartilage, or between Membranes?

It has been matter of dispute whether bone is formed within cartilage, or rather within jelly *, or

* Dr MACDONALD's experiments seem to me to have proved, that what has been commonly stated to be cartilage, is either jelly or soft bone. He has justly observed: "Quemadmodum "vero gelatinosa materia in cartilaginem convertatur, HALLERUS, "pariter atque auctores qui ante eum florebant, in errorem in-"cidit. Adeo enim non dicit, vasa in gelatinosâ materiâ ad "cartilaginem formandam conferre, ut existere neget. Affirmat "enim particulas opacas adparere, nondum apparente san-

on membranes. There are examples of both in the human body: in the extremities of the body, bone is formed within cartilage; but in the head between membranes.

" guine, et quandocunque massa gelatinosa opaca et elastica " facta sit, tunc pro cartilagine habenda.

" Putet itaque oportet, gelatum coagulatione, sive fluidarum " partium absorptione, in cartilaginem mutari. Coagulatio au- " tem rarissime, et nonnisi casu, in corpore vivo accidit, et ab- " sorptio gelatinam in cartilaginem mutare non potest.

" Gelatum vero vasis sanguiferis non caret, sed præ exigui- " tate, non conspici possunt, nisi, ubi ex periosteo gelatinosam " materiam intrant, et in cartilaginem formari non potest, nisi " vasorum ope.

" Ad hæc quæsita, nihil certò cognitum respondere possumus. " Quod ad me attinet; an gelatum in cartilaginem veram un- " quam convertatur, multum dubito. Magis inclinat mihi ani- " mus, ut credam, substantiam, quæ pro cartilagine habita est, " reverà os ipsum esse etiamnum molle ac flexile, quod postea, " phosphate calcis adjecto, indurescit.

" Quædam in meis experimentis observata, me ad hanc opi- " nionem incitârunt. Semper enim observavi os novum initio " molle, flexile, secatu et in annulum curvatu facile, et uno verbo " cartilagini simillimum: et reverà cartilaginem fuisse putâssem, " nisi animal alimento rubia tinctorum colorato nutritum fuis- " set; quod demonstrabat, hanc substantiam, mollem et flexi- " lem, non esse cartilaginem, sed os ipsum; nam rubra erat, " quod fieri non potuisset, si fuisset cartilago *."

" * Allen's eruditus Physiologiæ prælector mecum communicavit, se, " nuperrime cartilaginem chimicæ analysi subjecisse, qua demonstratur eam " solummodo continere, .01 partem calcariæ materiæ, quæ maxime ex car- " bonate calcis constat. Inde patet, quare cartilago rubiâ nunquam colo- " ratur."

Is Bone deposited in a solid or fluid state?

Solid bone has been supposed by Dr NISBET to exist in the blood. "What has now been observed concerning the different manners of bony production, and the phenomena which are visible during the progress of ossifications within cartilaginous parts, are fully sufficient to prove all bony particles to be originally contained in the blood, or a fluid secreted from it *."

According to BONHOMME, the process of ossification may be accelerated, by mixing a proportion of phosphate of lime with the food of animals; and diseases originating from a deficiency of earthy matter in the bones, may be cured by similar means.

But the above observations are entirely hypothetical, and throw no light on the subject they profess to explain. As a proof that secretion is a much more complex process than the merely straining through vessels certain solids or fluids which exist in the blood, I shall cite an experiment of VAUQUELIN, who confined a hen for a fortnight, carefully examined the food of the animal and the eggs she laid, and found, that in that space of time there was an excess of 500 grains of the carbonate of lime, but that a portion of the silica had disappeared.

* Vid. Human Osteogeny, p. 27.

To me it seems much more probable, that the bony matter is held in solution by an acid, probably by the phosphoric acid, which is abstracted from it by the absorbent vessels, or that the bony matter is mixed largely with the lymph.

The Phenomena of the process of Ossification.

When ossification is about to take place, there is an increased determination of blood to the part, the bloodvessels of which become suddenly larger, and admit the red globules of the blood. In a short time, a number of white spots may be observed attached to the extremities of the arteries. According to some authors, the bony matter exudes through the sides or extremities of the arteries; and according to others, the arteries are converted into bone.

The earthy matter of the bones is not deposited in an uniform manner, and, in proportion as the bone is deposited, the jelly or seeming cartilage is absorbed; and thus the cavities of the bones are formed. In process of time, the bony specks appended to the arteries coalesce, and become of a firmer consistence, after which layers of bone are added internally. The process of ossification is not carried on with equal rapidity in the different bones of the same animal, or with equal rapidity in the different classes of animals; and there are some cartilages, as those of the ribs and larynx,

which in the sound body are not converted into bone.

In the case of fractured bones, there is very great difference as to the time in which the fractured pieces are re-united, which depends upon the bone that is broken, the age, the constitution, the kind of fracture, and extent of the injury which is done to the neighbouring parts, and also upon the manner in which the fracture is treated.

Of the Source of Bone.

This subject has been much agitated by physiologists, and has given rise to much contrariety of opinion. According to some authors, the bone is derived from the vessels of the periosteum; and according to others, from the arteries proper to the substance of the bones.

Mr Du Hamel was a strenuous supporter of the first of the above hypotheses, and supposed that the layers of the periosteum were gradually converted into bone, in the same manner as timber is formed by the hardening of the white substance between the inner bark and the wood. He endeavoured to give weight to his favourite theory, by feeding animals with madder for a time, and then on ordinary food, by which the bones were rendered alternately white and red.

That the vessels of the periosteum form bone, is rendered probable from the effect of external violence, which is in some cases followed by the

destruction and exfoliation of the external layers of the bone, and in others by a new growth of bone, which includes the original bone which has been reduced to a gangrenous state, and is cast off; and also from the phenomena observed during the growth of horns.

My Father entertained a favourable opinion of Du Hamel's theory, and thus expressed himself in his Lectures:

"The periosteum has a greater effect in repairing the loss of bones from accident than Du Hamel himself is aware of. For, from his arguments, and from a number of additional circumstances, it appears, that the supply is very much made by the periosteum, though not entirely so, for the vessels of bones can furnish a matter that is similar to the rest. We find, on breaking the bones of animals, and tracing the fracture, that at first the periosteum around the bone inflames, and swells enormously, beyond what you would imagine, especially if the animal is young. I have seen it one-fourth of an inch in thickness in a pig after a fracture. With time, that is, in the space of a fortnight or three weeks, we find new earthy matter beginning to be deposited.

"Now, some, as Haller, have alleged, that indeed the periosteum swells after a fracture, because it has a certain degree of irritability, but that the swelling subsides again, without producing bone.

"When the callus has been completed, the parts are put together, as nature joins the broken pieces of the branch of a tree.

"The bark, a tough substance, does not readily yield, and on tying up the broken branch of the tree, there is very little growth between the woody parts, and the fracture is healed by a ringlet of wood from the bark.

"Our bones are re-united in the same manner, and the new addition is not confined to the broken place, but if the accident is produced by great violence, there is an addition made to the tables from end to end.

"We might suppose this owing to irritation on the vessels of the bone, but it is owing in a great measure to the new addition, and we find cells containing marrow interposed; and when we inject the vessels of the callus, which are numerous and large, we can trace them from the external periosteum.

"I do not affirm that no vessels go in from the ends of the bones; but they are few, compared with those from without.

"Nay, we find vessels running from the callus to the marrow; and though we inflame the marrow, its vessels do not possess the power of generating bone, but rather form a substance like the marrow.

"Next, upon taking out a part of any bone, as of the cranium, we do not find the hole filled up from the sides.

" The sides do swell, from the irritation and inflammation; but there are first a number of vessels shooting from the pericranium, or dura mater, (which is the pericranium within the skull), and from the extremity of these a plug is formed like a cork, which plugs up the hole *."

My relation Dr MACDONALD, who was a pupil of my Father, and heard him make the above observations, also made a number of very ingenious experiments, from which he has drawn the following inferences:

" Primo, vidimus ossis fracti extrema periosteo destituta, per spatium quo se invicem transibant, aspera, et primo stadio obducta sanguine coagulato, qui, partim ex periosteo dilacerato, partim ex cavo medullari, effusus videbatur. Ultra partem, qua extrema se invicem transibant, periosteum inflammatum ac densum reperimus, cui subjacebat materia gelatinosa effusa, cum sanguine coagulato, quocum extrema fracti ossis erant obducta, coalescens. Quod quidem notatu dignissimum est, coagulatus sanguis, quo longius a fracta ossis parte distabat, et quo diutius post experimentum inspexi, eo languidius ruber erat, eoque magis in album inclinavit.

* This quotation is taken from a manuscript copy of my Father's Lectures, which was originally written by Mr THORBURN, who was his pupil in 1770. Many copies of this manuscript are in circulation.

"Constat itaque, callum a sanguine coagulato incipere, qui, particulis rubris absorptis, in materiam gelatinosam convertitur. Ita esse constat, quod partes, quas periosteum vetus obtegit, primùm ruborem amittunt. His dum nascitur callus observatis, substantiam gelatinosam in experimentis *Ordinis* II. in quibus periosteum destructum fuerat, eodem modo oriri puto.

"In stadio sequenti, callum gelatinosum novo periosteo obductum, observavimus, quod formatur ex tela cellulosa musculorum superjacentium, ut ex *Eventu* VI. et VII. apparet. Hæc tela cellulosa vasa plurima a periosteo vetere accipit, ut verisimile nobis videtur, ex arcta, periostei regenerati cum vetere conjunctione. Initio hoc novum periosteum densum, sed, morbo procedente, naturaliter tenue evasit. Quinetiam ab initio arcte cum callo subjacente conjunctum erat, in quo nulla puncta ossifica, ante novum periosteum formatum, apparebant.

"Osseam materiam, primùm, in iis gelatinosæ materiæ partibus, quæ a medio callo longissime aberant, deponi observavimus. Hoc vero clarissime demonstrat, periosteum ad novum os formandum plurimùm conferre. Partes enim quæ primum indurescunt, periosteo vetere obducuntur, cujus vasa in callum, simul ut effusum, sanguinem distribuunt, unde deponatur ossea materia. Media verò calli pars, quippe periosteo nuda, per longum tempus in os indurescere non potest, sed cum primum, novum periosteum generatum est, in os etiam converti incipit, non vero in centro, sed in

superficie, periosteo proxima. Hinc dubito, an ossis atque medullæ vasa ad os formandum, necne conferant. Si conferant, certè conferunt multò minùs quàm periostei vasa *."

There are many instances in which ossification must take place independently of the periosteum.

The ossification of the extremities of the bones which are in a state of epiphysis, begins in the very centre of the seeming cartilage; and the same takes place in the knee-pan, and in many cases of disease.

The above opinion gains weight, on considering in what manner the medullary canal increases in diameter.

In many instances of preternatural ossification, the periosteum can have no share in that process. I have had occasion to meet with several instances in which a considerable part of the medullary matter of the *brain* has been converted into bone; and with one case where the greater part of the muscular flesh of the *heart* had undergone a similar change. I have also met with three cases where a part of the substance of the *placenta* has been reduced to a state of bone.

* Vid. Thesis, p. 94, 95, 96.

The importance of these observations, with which the public at large are not acquainted, as they were published in a Thesis, the circulation of which is but circumscribed, seems to me to render any apology for the length of the above quotation superfluous.

Upon the whole, to me it seems probable, that the arteries of the periosteum, and also those of the substance of the bone, form bone. The power of the vessels of the periosteum is manifest, and also that of the vessels of the bone, and especially during the growth of bones. In young animals, the medullary canal is very small; an absorption takes place internally, while there is a deposition externally from the vessels of the bone, which bears a certain proportion to the absorption: thus the bones increase in bulk.

Different theories have been published respecting the cause which determines the vessels of the periosteum, or of the bone itself, to begin and carry on the process of ossification.

Some have imputed it to the effect of pressure.

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels, as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From

which again we can understand one reason, why the bones of young animals sooner reunite after a fracture than those of old, and why cattle that are put too soon to hard labour, are seldom of such large size as others of the same brood which are longer kept from labour."

But the above theory of my GRANDFATHER, BARON HALLER, and others, is inadequate to the explanation of the process of ossification, which, in many cases, takes place where pressure cannot exert its influence. Bony matter is secreted from the blood, like the bile or urine, and formed into its proper consistence by the action of the circulating and absorbent vessels, and independently of pressure, which cannot be admitted to be the principal cause of ossification. Pressure, after the bones have been formed, may perhaps have some effect in condensing them.

Climate may also accelerate the process of ossification. Whence, in hot countries, the inhabitants sooner come to their height of stature than in the northerly cold regions.

Authors on the Bones of the Adult.

VESALIUS, De Corporis Humani fabrica.
CHESELDEN's Osteology.
HAVERS's Osteology.
BERTIN's Osteology.
B. S. ALBINUS, Tab. Sceleti Corpor. Human.
De Sceleto Humano.
Annot. Acad. libri octo.

Scarpa, De penit. Ossium structura.
Monro's Osteology.
Ditto, translated by Sue of Paris.
Loschege, Progr. de Symmetria corp. humani, imprimis Sceleti.
Soemmering's Anatomy, vol. 1.

The best figures of the Bones are the wooden figures by Calcare, in the original edition of Vesalius, and those of Albinus.

Authors on National Peculiarities of the Bones.

Herodotus. Vesalius.
Camper on the Natural difference of feature in persons of different countries.
Blumenbach, De generis humani varietate nativa; and his Decades Craniorum diversarum gentium.
Gibson, Thesis, De forma Ossium gentilitia.

Authors on the Formation of Bone.

Macdonald, Thesis De Necrosi et Callo.
Troja, De Ossium Regeneratione.
David, Obs. sur une malad. d'os.
Koeller, Experiment. circa Ossium regenerat.
Du Hamel, Mem. de l'Acad. Roy. des Scien. 1743.
Haller, Element. Physiolog. vol. viii.

Authors on the distinctions between the Male and Female Skeletons.

Monro's Osteology.
Soemmering's Anatomy, vol. 1.; and his Engraving of the Female Skeleton.

Authors on the Bones of the Fœtus.

MALPIGHI.
NESBITT'S Human Osteogeny.
ALBINI, Icon. Ossium Fœtûs humani.

CHAPTER III.

GENERAL OBSERVATIONS ON CARTILAGE.

CARTILAGE may be distinguished from other animal substances, by its grey pearly or opal-like colour,—by the remarkable smoothness of its surface,—by its elasticity,—by its semi-pellucidity, and by being much lighter than bone.

The cartilages, when macerated for some time in water, exhibit a fibrous structure.

Cartilage forms a considerable share of those organs where it is necessary to combine flexibility with a certain degree of firmness, in order that the part may always preserve a certain form.

Cartilages are covered by a membrane called *Perichondrium*, which is somewhat similar in its office to the periosteum; serving to conduct the small vessels which enter into the substance of the cartilages.

Chemical Analysis of Cartilage.

As no experiments seem to have been performed upon human cartilages, I requested Mr JOHN DAVY to examine it.

"In compliance with your request, I have made a few experiments on human cartilage; the following results of which, are such as might have been expected, and are agreeable to the conclusion generally drawn from Mr HATCHETT's interesting researches, that cartilage is principally condensed albumen.

"That which I have examined, and which anatomists call *obducent cartilage*, was apparently free from bone, and quite pure.

"A quantity of it was boiled in water in a glass vessel for about an hour. The water was thus rendered cloudy in a slight degree. Infusion of nut-galls added to it produced a small precipitate; solution of corrosive sublimate had a similar effect; but acetite of lead occasioned a much more copious one. The cartilage was washed with fresh cold water, and again boiled for about three hours. The precipitate now produced by infusion of nut-galls and corrosive sublimate in the water, was considerably less than in the first instance; and the effect of the acetite of lead was still more diminished.

"The cold sulphuric and muriatic acids acted on it very slowly; the former, after twenty-four

hours, had acquired from a small portion of cartilage that it had dissolved, a reddish-brown colour; and the latter, though most of the cartilage had disappeared, yet remained colourless. The nitric acid acted readily on it, and formed a yellow solution.

"Both the concentrated sulphuric and muriatic acid quickly dissolved it, when assisted by a gentle heat. The sulphuric solution was of a dark reddish-brown, and the muriatic was of a light reddish purple.

"A strong solution of potash also easily dissolved it.

"100 grains of it were slowly, but completely dried. In this state it had the appearance of horn, being brittle, and semitransparent. The loss it sustained was equal to 55 grains.

"The dried cartilage was heated to redness in a platina crucible: it swelled up very much, seemed to fuse, inflamed, and left a bulky charcoal. This charcoal incinerated, afforded about $\frac{1}{2}$ grain of earthy matter, which, as it dissolved in nitric acid, and was again precipitated by ammonia, appeared to be phosphate of lime.

"Hence, it may be concluded that 100 parts of human cartilage consist of about

44.5	Albumen.
55.0	Water.
.5	Phosphate of Lime.
100.0	

"The effects of the acetite of lead and the infusion of nut-galls, as they were greatly diminished on the water in which the cartilage was a second time boiled, may be fairly attributed to a little adhering extraneous animal matter, or to the perichondrium itself, and not to the cartilage."

Bloodvessels of Cartilage.

The bloodvessels of cartilage are extremely small, and do not give passage to red blood, or the powder of vermilion.

Lymphatic vessels of Cartilage.

The absorbent vessels of cartilage cannot be demonstrated; but their existence is sufficiently obvious, as cartilages are absorbed during the process of ossification, and from the effects of many diseases.

Nerves of Cartilage.

The cartilages in their healthy state do not possess much sensibility, and nerves cannot be demonstrated in them.

The cartilages when destroyed are not regenerated.

The Cartilages have been divided by anatomists into two great classes, viz. into those which are *permanent*, and those which are *temporary* only.

The permanent cartilages are the Articular, Interarticular, and Intervertebral, those of the External Ear, of the Nose, Eyelids, Larynx, and Windpipe.

Of the Articular, or Obducent Cartilages.

Those cartilages which cover the extremities of the bones, and form the articulating surfaces, have been named *articulating*, or *obducent* cartilages.

They are remarkably smooth on the surface, lubricated by synovia, and of unequal thickness, being thickest towards the centre.

The fibres of this kind of cartilage are remarkably small, and can be seen only after maceration for six or eight weeks in water; they then may be observed to be united at right angles in respect to the bone to which they are connected.

These cartilages being remarkably elastic, tend to avert the bad effects of concussion.

Of the Interarticular Cartilages.

The term *interarticular cartilage* is descriptive of the situation of these cartilages, some of which are moveable, but others are immoveable.

The interarticular cartilages are harder than the former, and are thinner in the centre than towards their circumference.

The interarticular cartilages tend to increase the surfaces of application of the articulating sur-

faces; they form a variable socket, the lines of which assume a different curvature in different inclinations of the bones; they adapt the surfaces of articulation to each other more accurately, and thereby add to the security of the joint, and also to the sphere of its action, of which the articulation of the under jaw affords a well marked example.

Of the Connecting Cartilages.

Contiguous bones, as the ossa innominata and sacrum, the ossa pubis, the sternum, ribs and vertebræ, are united by cartilages.

The Intervertebral Cartilages are of a very peculiar kind; being composed of an intermixture of cartilage and ligament, they partake of the properties of both: thus the very opposite properties, elasticity, flexibility and firmness, are combined *.

In the centre of these intervertebral cartilages, there is a glutinous substance, which is the centre of motion.

These cartilages impart a great degree of elasticity to the spine, and have a very great effect in facilitating its movements; for the bones work upon the intermediate cartilages.

These cartilages are very compressible; and hence a tall young man loses sensibly of his

* For a more particular account of these, see article *Spine*.

height during the day, which he regains when in bed, upon the pressure of the superincumbent parts being removed.

On the same principle the stoop of old age may be explained. On account of weakness of the muscles of the back, old people bend forwards, by which the fore-parts of the intervertebral cartilages, which are much compressed, become on account of that pressure much thinner.

The cartilages connecting the ribs to the breast-bone may be enumerated among this class of cartilages.

These cartilages may be resolved, by long maceration, into layers, of an oval figure, which are conjoined by a number of cross layers.

The cartilages which unite the ribs to the breast-bone, are powerful agents in expiration; being twisted during the elevation of the ribs, their elastic re-action tends to pull down the ribs.

Of the substance, like Cartilage, in which Bone is formed.

This substance, within which bone is formed, is composed of transverse and longitudinal fibres. These cartilages are of essential use: thus the body of the fœtus is more readily adapted to the form of the uterus of the mother; thus the sockets of the bones, which are cartilaginous, increase in proportion as the heads of the included bones, as in the hip-joint: hence there is less risk of dislocation.

In the skeleton of a child there are also cartilages between the bodies of the bones and their epiphyses, and which generally disappear about the period of puberty.

Vid. HAASE, De Fabrica Cartilaginum; and Dr W. HUNTER on the Structure of Cartilages, Lond. Phil. Trans.

CHAPTER IV.

GENERAL OBSERVATIONS ON LIGAMENTS.

THE LIGAMENTS are compact, strong and flexible membranes, and possess but a small share of elasticity.

The ligaments are composed of two layers: the outer layer is considerably thicker than the inner, upon which the smaller ramifications of the arteries are distributed, which form a part of the synovia of the joint.

The ligaments are of a fibrous structure: in some cases, these are disposed in a parallel manner with respect to each other; but in others, they interlace each other.

The ligaments externally are rough, but internally smooth, and lubricated by synovia.

The ligaments are largely supplied with blood-vessels and nerves, which may be traced into their substance*.

There are different kinds of ligaments, which, on account of their shape or situation, have been arranged into six classes.

The *first* class comprehends the *capsular ligaments.*

These ligaments serve for retaining the articular surfaces of the bones in contact, to which the tendons and muscles crossing the joints, (especially when in a state of contraction, and when there is the greatest risk of the bones being displaced), essentially contribute.

The capsular ligaments are connected to the necks of the bones, or to that part where the bodies of the bones are joined with their epiphyses, and which, forming capsules including the joints, have been thence called *capsular ligaments.*

The capsular ligaments are not of an uniform extent nor of equal thickness.

The extent of the capsular ligament is proportioned to the degree of motion performed: thus, at the shoulder-joint, the capsular ligament is much longer than at the hip-joint, where the motions are much more limited.

* Vid. Monro on the Nervous System, p. 66.

The capsular ligaments are strengthened by tendons, with which they are in many cases intimately interwoven.

The capsular ligaments are thinner under the muscles which cross them, than elsewhere,—a sufficient proof that the joint derives security from the muscles which pass over it. Besides, there are irregular ligamentous bands dispersed over the capsular ligaments, which add considerably to their strength.

But where the movements of the joints are more limited; where flexion and extension only are performed, the capsular ligament is strengthened at its sides by the addition of ligamentous bands, which have been commonly called Lateral Ligaments, and these are firmly interwoven with the periosteum.

These lateral ligaments moderate and in some measure regulate the movements of the joints.

The *second* class includes those ligaments which *unite* the bones, which *do not* move upon each other; as the os sacrum, and os innominatum.

The *third* class includes those ligaments which *supply the place of tendons*, and these possess a greater share of elasticity than the other ligaments, and therefore save muscular power; such are the ligaments between the spinous processes of the vertebræ.

The *fourth* class comprehends such ligaments as *supply the place of bones;* as the ligaments which fill up the foramina obturatoria.

Under the same class, the ligaments called Interosseous, between the tibia and fibula, and the radius and ulna, which serve to unite the above bones, and to give origin to muscles, may perhaps be included.

The *fifth* class comprehends such ligaments *as form a socket, in which a moveable bone is lodged;* as the astragalus, which is lodged within the ligament stretched between the os calcis and os scaphoides.

The *sixth* class includes those ligaments which are *situated within the joints,* for the sake of additional security, and moderating and regulating the movements of the joints; as the round ligament of the hip-joint, and the crucial ligaments of the knee-joint.

The reflections of the periosteum and pleura, have been described as forming, within the thorax and abdomen, *ligaments* for retaining the liver, spleen, uterus, and bladder of urine, in their proper situation; and these constitute, according to some authors, *a distinct class* of ligaments.

Vid. WEITBRECHT, Syndesmologia, sive Historia Ligamentorum Corporis Humani, 4to; and CALDANI's very beautiful Figures of the Ligaments. MONRO on the Structure of Ligaments, in his Treatise on the Bursæ Mucosæ.

CHAPTER V.

GENERAL OBSERVATIONS ON THE SYNOVIA.

THE joints are lubricated by a quantity of a fluid called *Synovia.*

This fluid is, in most cases, as transparent as fresh made olive oil, but in others, it has a yellow hue, like olive oil which has been kept for some time.

The synovia is somewhat like the white of egg in consistence, and, like it, when agitated, froths.

My FATHER, in his treatise upon the Bursæ Mucosæ, has made the following observations upon the synovia:

"Immediately after an ox was killed, I opened the joints and large bursæ of the legs, and collected the liquors they contained.

"These were similar to each other in colour, smell, taste, consistence and weight, and gave the same degree of slipperiness when rubbed between the thumb and finger.

"When mixed with oil of vitriol, diluted with double its weight of water, both liquors became demi-opaque, but were not coagulated.

"When two parts of these liquors were mixed with three parts of rectified spirit of wine, a portion, weighing nearly one-eighth part of the whole, was coagulated.

"When these liquors were brought to a boiling heat, they became less pellucid, and more viscid; but the quantity of matter which clotted, was very inconsiderable.

"When evaporated to dryness, they produced a tough crust, which weighed a small part only of the whole, and burnt in the flame of a candle, nearly as a thin slice of horn does."

The only other chemical experiments which have been made upon this fluid, are those of Mr MARQUERON*.

In these circumstances, I requested Mr JOHN DAVY to examine the synovia of the ox; with which request he readily complied, and has enabled me to add the following statement:

"The synovia you had the goodness to give me, resembles in physical properties the white of an egg, more than any other animal fluid I am acquainted with. It is very viscid, and at the same time remarkably soft, smooth, and slippery to the touch; so that it is admirably adapted for the office which it has to perform, of lubricating the joints. It has a slight taste of common salt, and a just perceptible smell. It froths when carelessly

* Annales de Chimie, tom. 14.

agitated, but does not when care is taken to prevent air being entangled by its parts.

" Its chemical properties are not so similar to those of the white of an egg as its physical ones. It readily mixes with water. Heat renders it turbid, and occasions the coagulation of a small proportion of albumen. Diluted acids render it cloudy in a slight degree; but their effect is not equal to that of a boiling temperature. The latter not only produces an evident coagulation, but likewise destroys the peculiar viscidity of the fluid, which the acids do not affect. The sulphuric, muriatic and nitric acids, in their concentrated state, first occasion a slight coagulation, and in a short time a perfect solution of the synovia, and a destruction of its viscidity. The sulphuric solution was of a light brownish yellow; the nitric of a light wine yellow; and the muriatic solution was colourless. Ammonia and potash appeared to have little effect on it. Corrosive sublimate, infusion of nut-galls, and acetite of lead, each produced a precipitate, and deprived the synovia of its viscidity. The precipitate by acetite of lead apparently exceeded in quantity that by corrosive sublimate, but was less than that which infusion of nut-galls afforded.

" From these results, synovia seems to contain albumen, gelatin and mucilage; and it also contains common salt, a small proportion of free alkali, and slight traces of phosphat of lime.

"I have endeavoured to ascertain the proportions of its constituent parts; but I have not been so successful as I could have wished, on account of the small quantity operated upon.

"300 grains of it were immersed in boiling water, in a suitable glass vessel, for about ten minutes. The coagulum thus formed was separated, and dried till very brittle. It weighed 1.4 grain.

"The fluid, after the removal of the coagulated albumen, was almost transparent. When nearly evaporated to dryness, the little remaining fluid did not gelatinize on cooling. The dry residual matter weighed 8.5 grains.

"This residue and the albumen were heated to redness in a platina crucible. The charcoal produced was digested in water. The solution thus formed was evaporated to dryness, and small cubic crystals of common salt were obtained, that weighed $\frac{1}{10}$th of a grain. As they shewed no tendency to deliquesce, though they rendered turmeric paper brown, it may be concluded that the quantity of alkali present was very small.

"The coal, after the separation of the common salt, was digested in dilute nitric acid. Ammonia afterwards added, occasioned a slight cloudiness, indicating a very minute proportion only of phosphate of lime.

"From the results of these experiments, 100 parts of synovia seem to contain—

98.3 water.
.93 gelatine and mucilage.
.53 albumen.
.23 common salt.
— traces of fixed alkali and phosphate of lime.

100.00

Of the Source of the Synovia.

It was formerly supposed, that there were small glands, which were lodged and protected by the masses of fat within the joints, from which this liquor was derived *; but my Father has observed: "I have not been able to discover the smallest vestige of any knotty, granulous, or glandular body lodged within these fatty masses, in the joints of man or other animals.

"Nay, although we observe so many bloodvessels dispersed upon the membranes of these fatty bodies, and upon the fimbriæ, and though we cannot doubt these fimbriæ consist of ducts which contain

* Vid. Havers, Ost. Nov. Morgagni, Advers. 11. Winslow, Exp. ann. 1732. Weitbrecht, Syndesmologia. Haller, Elem. Phys. vol. II. Plenck, Primæ Lin. 1775. Haase, de Unguine Articulari. Sabatier, Tr. d'Anat. 1780, tom. i. p. 9.

a lubricating liquor, and though in fact, when we press upon them, we are sensible that it issues from them; yet their cavities and orifices are so minute, that I have not yet been able to get a distinct view of them, though I employed magnifying glasses.

"These fimbriæ seem, therefore, to be ducts, like to those of the urethra, which prepare a mucilaginous liquor, without the assistance of any knotty or glandular organ; while by the pressure which the motion of the joints or tendons makes upon their sides, they throw out their liquor in greatest quantity when it is most needed. Perhaps the secretion, as well as the excretion of the liquor, is promoted, as in the salivary glands, by motion; and as the extremities of these fringes hang loose into the cavity of the joint, their liquor cannot be pressed back into them by the motion of the joint *."

Upon the whole, the synovia seems to be furnished by invisible exhalant arteries,—by the ducts of the fimbriæ,—and by oil exuding from the adipose follicles, by passages not yet discovered. We may suppose these passages to be very minute, not only because they are not to be seen by the microscope, but because the oily matter is so well incorporated with the mucilaginous, as not to be distinguishable even with the microscope, in the form of globules.

* Vid. Treatise on the Bursæ Mucosæ, p. 29, 30.

CHAPTER VI.

GENERAL OBSERVATIONS ON THE MUSCLES AND TENDONS.

THE Flesh, or Muscles, constitute a large share of the bulk of the bodies of animals.

The muscles are subservient to various and very important offices in the animal economy: they are the instruments of locomotion, of speech, chewing, sucking, swallowing, singing, circulation, and respiration; and by the same means, the contents of the alimentary canal, and of the different excretory ducts of the glands, are promoted and discharged.

The muscles are composed of moist, soft, flexible, semipellucid fibres, of different sizes, possessing a small share of elasticity, which in the class mammalia are of a red colour, and which are disposed in a parallel manner with respect to each other; and each of these muscular fibres is involved and connected by a cellular membrane, in which albumen, jelly and fat are lodged, which are in greater or less quantity, according as the animal is fat or lean.

The size of the muscular fibre is not proportioned to the bulk of the animal: it varies also in

the different muscles of the same animal, and bears a ratio to the strength of the muscle; for the muscles are invigorated, become larger by use, and acquire greater force and energy: hence the difference in the size of the muscles of the Hercules Farnese, Antinous, and Venus de Medicis. This truth is also strongly exemplified, by comparing the same muscles in wild and domestic birds. The former are hard, red coloured, fibrous, tough, and strong smelling; the latter are soft, white, and delicate. The form of the different muscles is very various; being modified and adapted to their particular office, as it is a law in the animal economy, that a muscle always contracts towards its centre.

The larger fibres of the muscles may be subdivided into smaller fibres. LEEWENHOEK, whose microscopical observations were so celebrated, supposed he had discovered the ultimate division of a muscle, and calculates, that in the fibres of some muscles there are 3200 filaments. The ultimate filaments have been said to be solid *, hollow †, or vesicular ‡. To me, the smaller fibres seem to be perfectly similar to the larger.

* GOTTSCHED. BOERHAAVE.

† BORELLI, HOOKE, STEWART, BERNOUILLI, BAGLIVI, ASTRUC, SENAC, QUESNAY.

‡ MUYS, COWPER, KAAW BOERHAAVE.

Bloodvessels of Muscles.

The bellies of muscles of the class Mammalia derive their red colour from the number of bloodvessels which are dispersed through their whole substance; for their fibres, when steeped in water, are found to be white, and very like to the fibrina of the blood.

Lymphatic vessels of Muscles.

Besides bloodvessels, the muscles have large and numerous lymphatic vessels.

It is probable that we have as yet discovered only a few of the lymphatic vessels which are proper to the human muscles; for the valves of these vessels perform their office so accurately, as to prevent even a very fine liquor from passing from the larger into the smaller ramifications.

But in the skate*, there are no valves in the small lymphatic vessels; and hence by a successful injection the smaller branches of the lymphatic vessels may be filled; and these vessels, when filled by a liquor coloured with vermilion, are so abundant as to give a red tinge to the part.

Nerves of Muscles.

The bloodvessels of the muscles are accompanied by nerves, which divide into so many and so

* Vid. MONRO on Fishes.

small branches, as to elude the knife of the anatomist.

The nerves of the muscles are not proportioned to their size; those of the muscles of voluntary motion being large and numerous, whereas those of the involuntary muscles are very small. The nerves of the heart are so small, as to lead BEHRENDS * to deny their existence, which, for the anatomist, was a fortunate circumstance, as it gave rise to the publication of SCARPA'S very beautiful and correct representations of the nerves of the neck and thorax.

Many muscles receive nerves from various sources, and antagonist muscles, in many instances, from the same sources †.

Wounds, laceration, inflammation, and other diseases, prove the great sensibility of these organs.

The muscles have been called by some authors the *moving extremities of the nerves*, upon which opinion my Father has published the following comment:

1. "Muscular fibres, in consequence of their office, have considerable strength and toughness; whereas the nerves, even when covered with their pia mater, (which those very authors suppose them

* Vid. LUDWIG, Scriptor. Neurolog. Minor, vol. III.

† Vid. MONRO'S Nervous System.

to lay aside at their terminations), are pulpy and soft.

2. "The matter which we know for certain to be medullary, or nervous, does not appear to be endowed with the power of contracting when irritated.

3. "As the nerves consist of threads laid parallel to each other, and which do not, like the blood-vessels, divide into branches, the bulk of which greatly exceeds that of the trunks which produce them, how are we to conceive that a small nerve can form a much larger mass of flesh?

4. "If the muscles were formed by the extremities of the nerves, they should shrink very remarkably on cutting the nerves, instead of which, I have observed no sensible alteration in the appearance of the muscles of the thigh and leg of a frog, upwards of a year after I had cut across its spinal marrow or sciatic nerves.

"Muscles, or muscular fibres, seem, therefore, to be *organs sui generis*, not produced by the nerves, but merely influenced by the energy they convey *."

Tendons of Muscles.

The tendons, like the muscles, are in structure fibrous, but their fibres are white, small, and closely united to each other; hence they have a shining silvery appearance.

* Vid. Nervous System, p. 90. and 91.

In many of the tendons, the fibres follow nearly the same direction as the fibres of the muscles: hence tendons have been stated by some authors *to be muscles indurated by pressure.* But the direction of the fibres of the tendons is in many instances different from that of the muscles; for there are many muscles with rectilinear tendons, and also tendons with rectilinear fibres, common to two muscles, the fibres of which have different degrees of obliquity.

There are many muscles in which the tendon occupies the middle of the muscle, and the fibres are placed obliquely with respect to the tendon, like the plume of a pen. Such muscles have been named *Penniform muscles.* There are other muscles, in which the tendons are situated at the sides of the muscles; these have been called *Semi-penniform:* and in some muscles several penniform muscles are combined, which have been named *Compound penniform muscles* *.

The tendons are subservient to various purposes.

1*st*, They serve to unite the cartilages and bones to each other; as where they supply the place of the external intercostal muscles, or where they unite the bones of the fore-arm or of the leg to each other.

2*d*, Tendons add to the strength of the capsular ligaments.

3*d*, The tendinous aponeuroses, as the fasciæ of

* Vid. Plate 2.

the superior and inferior extremities, are conducive to the symmetry of the body, and particularly to that of the limbs, and also to the defence of the muscles.

4th, The tendinous aponeuroses not only defend the muscles, but increase greatly the surfaces from which the muscular fibres take their origin; of which there are many examples in the back, and in the extremities of the body, in the fore-arms, thighs and legs; and in some places there are two or more muscles, the fibres of which are differently directed, and subservient to different purposes, taking their origin from the opposite sides of the same tendinous membrane.

5th, There are rounded tendinous cords, which serve to connect muscles to distant bones, where there is not room for the bellies of all the muscles which are necessary for the motions of the joints; and without such a medium of attachment, the joints must have been unwieldy and of great bulk, and there might have been the risk of the muscles interfering with each other, or of the muscles proving injurious to the neighbouring bloodvessels and nerves.

6th, There are annular tendinous ligaments, as at the wrists and ankles, which serve to fix down the round tendons, and to strengthen the bursæ within which the tendons play.

Lastly, Some tendons fix down other tendons: thus the tendons of the long flexor muscles of the fingers and toes pass through each other.

Classification of Muscles.

There have been two methods of arranging the muscles. According to the one, muscles are arranged according to their uses; according to the other from their situation. The latter is the method of ALBINUS, which has been adopted by most of the modern anatomists.

Such a method is perhaps the most natural, and most favourable for teaching dissection, but it communicates a very imperfect idea of their uses, and of the mode in which they antagonize each other.

I propose to adopt both plans, viz. to name the muscles as they present upon dissection, and then to arrange them into classes, according to their several uses.

Nomenclature of Muscles.

The muscles of the human body have been named by DOUGLAS, ALBINUS, INNES, and other authors, from their size *, breadth †, and length ‡, form ¶, their being straight ‖, or oblique §, from

* Greater and smaller pectoral muscle.

† Latissimus dorsi, Vasti interni et externi, &c.

‡ Longissimus dorsi, Longus colli, &c.

¶ Deltoid, Rhomboid, Scaleni, Trapezii, &c.

‖ Rectus abdominis, Rectus cruris, &c.

§ Obliqui abdominis, Obliqui capitis, &c.

their situation *, or supposed office †; but there are many objections to such names.

In the following pages, it is proposed to adopt such names as are descriptive of the situation of the muscles; and where a muscle has several origins, it is necessary to employ such a name as describes the chief origins and insertions only, in order to avoid words of many syllables.

Origin and Insertion of Muscles.

A muscle is said by anatomists to consist of a belly and two extremities.

The *belly* is composed of a great number of fleshy fibres; and to the extremities of many of the muscles, a white glistening cord or membrane is connected, called *tendon*, or *tendinous aponeurosis*, by which many of the muscles are fixed to the bones.

The extremity, which is connected to the most fixed part, is named the *head*, or *origin* of the muscle; and the other extremity, fixed to the more moveable part, the *insertion* of the muscle.

Chemical Analysis of Muscles.

This branch of animal chemistry is still involved in obscurity, owing to the difficulty of sepa-

* Glutei, Pectoral, Orbiculares oculi, &c.

† Biceps flexor cubiti; Biceps flexor cruris; Attollens aurem; Corrugator supercilii; Levator, Depressor, Abductor, Adductor oculi; Sartorius, &c.

rating the muscular fibres from the blood, fat, and cellular substance, with which they are very intimately involved.

To Messrs THOUVENEL, FOURCROY, VAUQUELIN and HATCHETT, we are chiefly indebted for our knowledge of the chemical composition of the muscular fibre.

A muscle, when washed, is converted into a white fibrous substance, which retains the form of the muscle; this consists chiefly, of fibrin, 2 of albumen, 3 of jelly, 4 of extractive, 5 of phosphate of soda; and Mr HATCHETT discovered in beef, phosphate of ammonia, and the phosphate and carbonate of lime.

Contraction of Muscles.

The muscles are extremely irritable, and contract when irritated.

A power of contraction is the most characteristic property of a muscle.

The whole of a muscle, or only a part of it, contracts itself upon the application of a stimulus. It acts only by contractions, and when the exertion ceases, it relaxes itself considerably.

When a muscle contracts, the belly of the muscle becomes hard, rough on its surface, swells, its smaller fibres assume a waved or zig-zag appearance, and its extremities approach each other, and the muscle, in consequence of this action, draws

the least moveable towards the more fixed part, to which its extremity is connected.

When a hollow muscle contracts, it diminishes its cavity in all directions.

The muscular fibre varies its operation according to the purpose to be served; for instance, when a muscular fibre is punctured, it vibrates, which is the fittest means of throwing off the offending cause; the alimentary canal, acted on gently by the food, performs a very complex peristaltic motion and anti-peristaltic motion; the abdominal muscles act slowly and steadily in expelling the contents of the rectum, but suddenly and convulsively in vomiting; the bladder of urine, from which there is a small outlet only, performs a slow and uniform contraction in discharging its contents; whilst the heart contracts with a jerk, and is drawn towards the more fixed point.

A permanent and unusual degree of contraction in a muscle is called *spasm*; and when the contractions are quickly repeated, it is called *convulsion*.

Muscles, Voluntary, Involuntary, Mixed.

There are some muscles which are under the direct influence of the will; these have been called *voluntary muscles*.

Such are the muscles of locomotion.

But there are other muscles, over which the will has no dominion: these, therefore, have been

called *involuntary muscles:* we neither possess the power of throwing those muscles into action, nor can we prevent them from acting.

The heart, arteries, and intestines, afford examples of this description; and it is remarkable, that such muscles are not fatigued by continued action.

It may not be improper to add, that some of the muscles which are *not* in man obedient to the will, *are so* in animals: thus, in ruminating animals, the stomach is a voluntary muscle; and farther, even in the human body, those muscles which are involuntary are, in consequence of violent passions of the mind, sometimes excited, as palpitation of the heart, by anger or fear.

The nerves which lead to the *voluntary muscles* are much larger than those proper to the *involuntary muscles;* yet the irritability of the latter class is more durable, and more readily excited than that of the former class. The irritability, therefore, of a muscle, is by no means proportioned to the size of the nerves.

There is a third, and intermediate class of muscles, which has been named *mixed,* as we can at pleasure increase or modify their action, but cannot stop it altogether, or for a great length of time.

The diaphragm, and muscles of respiration, are included in this class.

Of the action of this third class of muscles we are not sensible, unless the attention of the mind be directed to it. When such muscles act in an

unnatural manner, or when their action is impeded, then we suffer very great distress.

Under this class the sphincter muscles may perhaps be included: they are not constantly, but only occasionally under the dominion of the will.

The degree of contraction of muscles is very various: it has generally been said that muscles *contract one third only of their length;* but many muscles, as those of the bladder of urine and the sphincter of the mouth, are capable *of contracting two-thirds,* if not more.

Does a muscle increase in its density when it contracts, as was formerly supposed?

Dr BLANE'S experiment on the tail of the eel seems to determine this question in the negative *.

* "I took a glass flask, into which one half of a living "eel was introduced. The mouth was immediately afterwards "fused by a blow-pipe, and drawn into a tube like the stem "of a thermometer. The flask and tube were then filled with "water, in order to see whether the motion of the animal would "make the fluid rise or fall. *It had neither the one effect nor "the other,* though there were at times strong convulsions; and "if the muscles had at any time occupied *either more space or "less than at another,* a sensible fluctuation would have been "produced, especially when the column of fluid was rendered "very fine, by the introduction of a steel-wire to irritate the "parts. That part of the eel from the anus to the tail was "made use of for this experiment, as the other division, con-"taining the organs of respiration and the air-bladder, might "have occasioned a fallacy, from the expansion or condensation "of an elastic fluid, by accidental changes of temperature or "compression. This was repeated three times, with the same "result. In one of the trials, the above-mentioned portion of

There are immense numbers of stimuli which produce the contraction of muscles, of which the nervous energy is certainly the chief.

The integrity of the *nerve* and artery leading to a muscle *is essential to its action;* for a ligature thrown around that nerve, or the dividing it, renders the muscle paralytic, or incapable of action; and further, the cause of this palsy is generally resident in the brain and spinal marrow, from whence the nerve originates, and not in the part affected.

Relaxation of Muscles.

Until the causes of contraction are fully understood, those which induce relaxation of the muscles must be obscure.

Contraction and relaxation take place regularly, and constantly and alternately in the heart, as the circulation could not otherwise have been properly carried on; and even after the heart is separated from the body, when its most common and principal stimulus the blood is wanting.

During respiration, contraction and relaxation alternately take place, but less regularly, for a great number of useful purposes.

The muscles which are commonly called voluntary, as those of the limbs, may remain in the state

"two eels was introduced; and though they were at times both "in convulsions at once, not the least motion of the fluid in the "tube could be perceived."—*Blane's Lecture on Muscular Motion,* p. 13.

of relaxation for a number of hours; and a sphincter muscle, such as the sphincter ani, may continue for the same number of hours in a state of contraction; and hence the voluntary muscles or the sphincter muscles cannot be said to be in an alternate state of contraction and relaxation, as we possess the power of throwing our muscles into that state which is most conducive to our safety and convenience.

The heart and the intercostal muscles are perhaps more completely relaxed than the voluntary muscles, in order that the blood and the air may enter the heart and lungs more freely.

The relaxation of the voluntary muscles is less complete, or in a sort of middle state, such as makes them ready for a greater degree of either state, without requiring such an exertion as exhausts the nervous energy.

A moderate degree of contraction is constantly taking place in all our muscles, as is evident in those of the face in the case of hemiplegia, the diseased side being evidently much more relaxed than the sound.

Observations on the Collocation of Muscles.

GALEN, in his treatise De Usu Partium, has described the several qualifications of each particular muscle, its position, figure, just magnitude, its fulcrum, its point of action, and its collocation with respect to its two ends.

The movements of the body are regulated by the form of the bones, the disposition of the articular surfaces, the manner in which the muscles are fixed to the bones, and the direction of the muscular fibres.

1st, *There is an exact relation between the joint and the muscles which move it.*

Thus, at the elbow and knee joints, there are muscles capable of performing flexion and extension only; but at the shoulder and hip joints, muscles are superadded, for performing the rotatory movements of which these joints admit.

2d, *Muscles act only by a contractile power; the contraction is succeeded by relaxation, by which the muscle returns to its former state.*

Such being the nature of the muscles, it follows, that motion can be produced only by the agency of antagonist muscles, of flexor and extensor muscles; and where balancing of the body is required, the flexions and extensions are accommodated to the centre of gravity, or *vice versâ.*

Such a disposition of the muscles is also conducive to the aspect and symmetry of the body: thus the mouth, for instance, is kept in the middle of the face, by the agency of the muscles of its opposite sides balancing each other, as is very evident when the equipoise is destroyed by a palsy of the muscles of one side of the face, then the mouth is drawn to the opposite side.

It is evident that the centre of gravity varies in the different attitudes of the body; and hence a

number of muscles must be thrown into action to maintain the equilibrium, or there are muscles which modify or limit the action of the flexor and extensor muscles.

3d, *The muscles are so disposed as not to interfere with one another.*

4th, *The action of many muscles accords with their position and form.*

From the position and form of the muscles an estimate may be formed of their action, the contraction of muscles being towards their centre, the figure of the muscle is adjusted, and its form modified so as to produce the necessary motion: thus the long muscles stretched between certain points, must draw these towards each other when they contract; a hollow muscle, like the bladder of urine, discharges its contents; and a sphincter muscle, from the circular disposition of its fibres, and its position, is well adapted for a contracted state, sufficient for retention, but which may be overcome when it is necessary.

5th, *Many of our movements are accomplished by the combined action of several muscles.*

The movements of many parts of our bodies are the result of the combined action of several muscles; and frequently, diagonal motion is produced, the tendons of the muscles pulling in the direction of the sides of a parallelogram; for example, the head is drawn downwards in the diagonal by the combined action of the sterno-cleido-mastoidei muscles, and sidewise towards the shoulder by the

combined action of the sterno-cleido-mastoid and the splenii muscles.

Strength of Muscles.

In order to form an estimate of the great strength of the muscles of the living body, it is necessary to examine with attention the manner in which these are inserted into the bones, and near to the joints, for their mechanism may be understood from the properties of the lever.

Most of the muscles are so disposed as to act with a mechanical disadvantage, being inserted into the bones near to the joints, and at an acute angle; they are levers of the third kind, situated between the fulcrum and the resistance.

But this loss of strength is fully compensated by the *velocity with which they act, and the extent of motion they produce;* for it is more useful to us to move a moderate weight with due expedition, and with a considerable sweep, than to possess the power of raising a much greater weight more slowly, and through smaller space.

By this contrivance, which is also conducive to the elegance and symmetry of the body, *there is a sacrifice of force to attain velocity.*

Thus, the insertions of the *biceps flexor cubiti,* and *brachialis internus,* are at an average not more than an inch and a half distant from the elbow-joint, the fulcrum on which the fore-arm moves; and therefore a weight placed in the hand, is at a

distance eight times greater from the elbow-joint: hence, if 50 lbs. can be raised on the hand, it is with a force with which 400 lbs. could have been raised, had the muscle been applied to the extremity of the hand.

Further, as the biceps and brachialis internus pull their origins downwards, with as much force as their insertions upwards, it is evident, that if we suppose these muscles to be thrown over a pulley, they could raise 400 *lbs. at each end, or in all* 800 *lbs.*, a weight which would certainly have torn these muscles in a dead person; so prodigious is the difference between the strength of the muscles in the living and the dead.

In the living body, by a sudden exertion, the *tendons* are more frequently lacerated than the flesh; but in the dead body, *the belly of the muscle* is generally torn; and I have observed, that when the inferior extremities had not been laid straight after death, as in the bodies of persons that had been hanged, and had become rigid in that bended posture, the muscles were torn by extending the limbs; and the rigidity which had taken place must probably have shortened and fixed all the fleshy fibres equally, so that we can scarcely suppose that one fibre was torn after another.

It has been attempted by Mr GRAHAM, Dr DESAGULIERS, Mr LE ROY, and Mr REGNIER *,

* Vid. Experiments made with Regnier's spring steel-yard, or dynamometer, by PERON, in order to compare the strength of Europeans with that of the inhabitants of New Holland and the adjacent islands.—*Vid. Peron's Voyages.*

to calculate, by means of a spring steel-yard, the force of muscles of animals and men; but when we consider, that one man is stronger than another in the legs, whilst another is stronger in the hands, and a third can lift a much greater weight,—the effect of habit in giving strength, mobility, and dexterity in the use of particular muscles, and the astonishing muscular efforts which delicate women are capable of making during a paroxysm of hysteria or mania, the insufficiency of such calculations appears obvious, being applicable to individual cases only, and even when we set aside the various causes which I shall enumerate, which tend to diminish the force of the muscles.

The causes which tend to diminish the force of muscles are,

1*st*, Half the power is exerted on a fixed part of the body.

2*dly*, When muscles act in concert, they do not act in the same line; hence the force must be as in the diagonal, and thus the muscular contraction is divided between different muscles, and fatigue of any particular muscle is avoided.

3*dly*, A great source of loss of power, results from the obliquity of the insertion of a muscle into the bone which it is intended to move.

4*thly*, Perhaps there may be another cause of loss of power, owing to a muscle passing over two joints, where a considerable part of its force is expended in pressing one bone against another at the articulation.

5thly, From the muscles being parrallel to the bones they move, there must be a great loss of power.

6thly, The fleshy fibres of a muscle are so disposed with respect to the tendon, as not to act in a line with it: hence a very great loss of power; and in like manner the general obliquity of the muscular fibres also produces, as in the penniform muscles, a great loss of power.

It merits mention also, that the loss of power arising from the position of the muscles, and manner in which their tendons are fixed into the bones, is in a degree counterbalanced by the multiplication of the fibres of the muscles, by the increased diameter of the extremities of the bones, and by the introduction of moveable bones, as the *patella* and *sesamoid bones*, which alter the direction of the muscles, and increase their power.

Of Oblique Muscles.

There are many *important advantages gained by the oblique course of the fibres of the muscles*, which are fully explained in the subjoined pages on that subject, with which I have been favoured by my Father.

Of the Varied Direction of the Fibres of our Muscles, and of the Effect of this upon our Motions.

1.

In many of our muscles, the fleshy fibres, instead of running in straight lines, or in lines nearly such, between their origins and insertions, are placed in oblique directions.

Before I attempt to explain the effects of the direction of the fleshy fibres, I shall describe the varieties of this in the different muscles of the human body.

1. In some muscles, as in the recti of the abdomen, the sartorius, the gracilis, &c. the fibres are directed, from the origins of the muscles to their insertions, in nearly parallel lines; and these may be called *straight* muscles; (see Plate 2. fig. 1. of this Treatise.)

2. In others, the muscle is of a triangular shape, and its fibres resemble the spokes of a wheel, or the sticks of a spread fan; and such muscles may be called *radiated.* The fibres in some of them diverge from the origin or fixed point, as is the case in the levator palpebræ superioris; and in others, as in the temporal, subscapularis, or great pectoral, they converge from their origins towards their insertions.

If the edges and middle parts of such muscles are in the same plane, they co-operate, of which the temporal and trapezius may be examples. But in others, as in the deltoid, the fibres are not in the same plane, but inclose a joint, and its oblique sides may be antagonists to its middle in one posture of the arm, viz. its hanging pos ure, but may co-operate with it when the arm is elevated.

3. In many muscles the fibres are parallel, or nearly so, to each other, but are laid obliquely between tendinous membranes, or between a bone and a tendinous membrane; and as their fleshy fibres resemble in their direction the plumage on one side of the stalk of a feather, they have been called *semipenniform* muscles. The flexors and extensors of the whole hand or foot, and the flexors and extensors of the fingers and toes, furnish striking examples of this kind of structure; (see Plate 2. fig. 2. of this Treatise.)

4. In some places the fleshy fibres run from both sides obliquely downwards, or obliquely upwards to a tendon in the middle of the muscles, resembling in their direction the plumage on both sides of the stem of a feather; and hence such are called *complete penniform* muscles. The flexor longus pollicis pedis (see ALBINUS) is an example, in which the fibres descend; and the rectus extensor cruris (see Plate 2. fig. 3.) an example in which they ascend from the sides of the muscle to the middle tendon. When we compare a complete penniform muscle with a semipenniform

muscle of the same breadth and thickness, as the number of its fibres is double, its strength will also be double to that of the semipenniform muscle.

5. We may next observe a combination of semipenniform muscles in the extensors of the forearm or leg, or *compound semipenniform* muscles.

6. In the soleus, we find a combination of complete penniform muscles, or a *compound penniform* muscle; (see Plate 2. fig. 4.)

7. In many other places we find oblique muscles co-operating, although they are not joined to each other by common tendons; as is the case of the two rows of intercostal muscles; and in many of those which are fixed to the head and spine. The sterno-mastoid, splenii, complexi, semi-spinales, multifidus spinæ, are all of them evidently of that description.

2.

HAVING described the various directions of the fibres in the muscular system, I shall now endeavour to explain the effects these have in the motions we perform.

In many instances the obliquity of the fleshy fibres is so great, that the fibres are very much shorter than if they had run directly from what is called the origin of the muscle to its insertion, or the fibres are much more numerous than if the same space had been covered by straight fibres. Thus, suppose a straight muscle to be fifteen inches long, and that this is cut transversely into

five equal parts, and these laid obliquely in such a manner as that their fibres form the diagonals of triangles, of which the height measures four inches and the basis three inches. If there was no loss of strength by their pulling obliquely, the five short muscles would raise five times the weight; but in fact one-fifth of the force is lost by their obliquity. Borellus, De Motu Musculorum, p. 92., proves, That the "potentia oblique trahens est ad resistentiam ut longitudo directionis oblique ad ejus sublimitatem." But after this deduction, the five oblique muscles could raise four times as much as the single straight one of the same breadth and thickness.

3.

We find in reality muscles which correspond very nearly with the above supposed structure. Thus, let us compare with each other two muscles, the figures of which are copied from the very accurate work of Albinus, in Plate 2. fig. 1. and 2.

Fig. 1. represents the sartorius muscle in which the fibres, which are of great length, are straight, and nearly parallel to each other. In the second figure, which represents the peroneus longus, which is nearly as long as the sartorius, the fibres are laid obliquely and semipenniform, and do not measure above a fifth part of the whole length of the muscle, from its uppermost to its undermost bundle of fibres; and when we attend to the degree of the obliquity of the muscular fibres, and

suppose these to form diagonals to right-angled triangles, the bases of such triangles, compared with the perpendiculars, will be very nearly in the proportion of 3 to 4; or the muscular fibres form, with their bases and perpendiculars, triangles, the sides of which are in proportion to each other, as the numbers 5, 4, & 3.

From the increase of strength which many muscles gain by having their fibres made shorter, though laid in an oblique direction, it was universally supposed by authors, that the increase of force was the *only* purpose served by the obliquity of their fibres.

4.

But to shew you, in the clearest manner, that nature may have other very different purposes in view, it will be found, that, in various instances, the strength of the muscle is diminished by the obliquity of its fibres. This is the case of many of the short muscles attached to the spine, as in the semi-spinalis colli et dorsi, multifidus spinæ, &c.

But the most striking instance of this is to be found in the intercostal muscles. For it is evident, that if their fibres had been straight or perpendicular to the ribs, they would have been not only much more numerous than in the oblique position, but would have acted upon the ribs with greater force.

In all these instances, one reason of the diminution of force is, that the oblique muscles are longer, and therefore have fewer fibres than straight ones supposed to fill the same space; and the other reason is, that a muscle loses force by pulling obliquely, in the proportion which its length bears to the length of the sine of the angle which it forms with an horizontal line, or to the length of a perpendicular joining two horizontal lines which pass through the origin and insertion of the muscle. Thus, if an oblique muscle deviates one half of a right angle from the perpendicular, it loses the one half exactly of its strength.

Thus, in Plate 3. fig. 1. let AB, BC, represent a log of wood; DD a hook in the roof of a room. Let DB DB represent two straight muscles, exerting their whole force in elevating the log ABBC, but the two oblique muscles DA and DC expend but one-half of their force in elevating the log; for the other half of their force is spent in endeavouring to draw the ends of the log towards each other. That is, the two straight muscles elevate the log with twice as much force as the two oblique muscles do. In other cases the force increases or diminishes according to the obliquity, by the general rule above stated. Thus, the two muscles DE and DF raise the log with one-fourth only of the force of the two muscles DB and DB.

To prove this experimentally, let two pullies A and B, (See Plate 3. fig. 2.) be fixed very near

to each other, in the top of a wall CD, and let two other pullies EF be fixed to the wall at double the distance from each other of the perpendicular height of the first pair of pullies above the second pair; that is, let the length of the horizontal line EF be double to that of the perpendicular line EC or CD. If a rope GHIK be now passed over the four pullies, and two weights L, M hung to its ends, it will be found, that the single weight N, of the same kind and bulk, hooked on the middle of the rope, as at O, will balance both the other weights L and M; because, as the oblique ropes H and I evidently pull inwards in the direction of the horizontal line EF, as much as in the direction of the perpendicular lines EC and FD, they lose one-half of their effects of elevating the weights.

In all examples, therefore, where a space between two parallel lines or bones, such as the ribs, is filled up with muscular fibres, there will be a greater number of fibres when they run transversely than when they are placed obliquely, and they will besides act with more force: And, even when we suppose the number of fibres in two muscles so situated to be equal, the muscle with straight fibres will be stronger than the oblique one, in the proportion exactly which the length of the oblique fibre bears to the straight or perpendicular one.

Hence, in all such cases, some advantages very different from an increase of strength, must be gained by the obliquity.

5.

To discover these, let us now compare, more exactly, with each other, the effects of straight and oblique muscles; and, in the *first* place, let us suppose them to be situated between two parallel lines, (See Plate 3. fig. 3.) Let AHH and KDE represent two parallel lines. Let ABCD represent a pair of straight muscles, and AFGE and AK a pair of oblique ones.

Let us next imagine, that each of these pairs of muscles can in action shorten itself one-third part of its length. On this supposition, the straight muscles will be able to bring the point A, which is supposed to be moveable, down to B, and will then have lost one-third of their length.

But when the pair of oblique muscles had by their action brought the point A down to B, they have not lost one-third of their length, as it is evident that the line BE, which subtends an obtuse angle, is longer than FE, which is equal in length to two-thirds of the oblique muscle.

Hence it appears, that a pair of oblique muscles placed between the same parallels with a pair of straight muscles, can, with less proportional decurtation, produce the same extent of motion that the straight muscles can do.

We may next prove that the oblique muscle has not lost so much of its length as is equal to one-third of the length of the straight muscle. For if we form an isosceles triangle ABL, (see Pl. 3. fig. 4.), as the two sides AB and BK of the triangle ABK

taken together are longer than the third side of that triangle, or than the straight line ALK, it follows, that BK must be longer than LK, or longer than the oblique muscle after one-third of the length of the straight one is taken off from it; or that the oblique muscle, after bringing its insertion to the same point as the straight muscle had done, has not lost so much of its length as the straight muscle had lost.

6.

I have found that I might go a step farther, and prove that two oblique can produce a more extensive motion than two straight muscles of the same length, and which at first sight seem much better fitted for the purpose.

Thus, in Plate 3. fig. 5. let the lines ABC DEF represent two straight muscles; and the lines ALMN two oblique muscles of the same length with the straight ones.

Let us next suppose that these muscles are capable of shortening themselves one-fifth of their length, and that the straight muscles have brought the point A down to B.

Let us next suppose that the two oblique muscles have done the same thing. It is now evident that the oblique muscles have not lost one-fifth part of their length; because the angle BLA of an isosceles triangle being smaller than a right angle, the angle BLN must be larger than it; or the angle BLN being equal to the two

angles ABL and BAL of the isosceles triangle, ABL must be larger than a right angle, and of course larger than the angle LBN; and therefore, as the side of a triangle which subtends the largest angle must be longer than either of the two other sides of the triangle, the side BN must be longer than LN; and therefore the oblique muscle has not lost one-fifth of its length, or has performed, with a smaller decurtation of its fibres, the same extent of motion as the straight muscle of the same length with it.

7.

On the same principles, we can prove that the extent of motion increases with the degree of the obliquity of the muscles. Thus, suppose that the oblique muscles AM and AL, (See Pl. 3. fig. 6.), after bringing the point A down to B, continue to act till they have brought the point B down to C, it appears that they are less shortened in this second action than they were in their first action; for on comparing together the two triangles BGL and CHL, the angles at G and H are equal, because the lines BG and CH are parallel to each other; but the angle HLC being larger than the angle GLB, it follows, that the angle GBL is a larger angle than the angle HCL, and therefore, that the side GL which subtends it, bears a larger proportion to the side BL than HL does to CL; that is, the decurtation of the oblique muscle will be less in its second action than in its first; or

CL is longer in proportion to BL, than BL is in proportion to AL.

Or, the same thing is made manifest in a more simple manner, by comparing together the triangles ABL, BCL, and CDL, in fig. 6., in which it is evident, that the line AL subtending the largest angle bears a greater proportion to BL, than BL does to CL.

Hence, as the degree of obliquity of an oblique muscle is gradually increasing during its action, its force is diminishing, whilst its effect of producing extensive motion is increasing.

8.

Having demonstrated geometrically the general proposition, I shall now illustrate it by applying arithmetical calculation.

Thus, (See Plate 3. fig. 7.), if we suppose two straight muscles, such as our recti abdominis, ABCDEF to be five inches long, and to shorten themselves, in contracting, one-fifth part of their length, they will draw the point A, which we shall call the ensiform cartilage, down to the letter B, or they will move it through a space of one inch only; but if we suppose the same muscles to be placed obliquely, and their origins fixed to the ossa ilia instead of the ossa pubis, and that a line drawn transversely between the ossa ilia measures eight inches, it is evident that they would draw the point A, or ensiform cartilage, three times farther, because they will not lose one-fifth of

their length till the ensiform cartilage is brought down to D, the middle of the line that is drawn between their origins.

Let us next suppose two muscles, each thirteen inches long, to be laid so obliquely, that a line drawn perpendicularly from their insertion to the middle of a line joining their origins (See Plate 3. fig. 8.) measures five inches. If these muscles shorten themselves a single inch, the place of their insertion will be moved through a space of five inches, or five times farther than it could be by the action of two straight muscles.

9.

To make the justness of these conclusions quite evident to those who have not been used to geometrical demonstrations, or arithmetical calculations, I shall now shew, by the figure of a wooden machine, an imitation of the effects of oblique muscles, (See Plate 3. fig. 9.)

In the middle of a piece of wood AAAA, I have cut a groove BC, the sides of which may represent two straight muscles. I now apply on each side a piece of metal BD, BD, representing an oblique muscle, stretched from the side of the base to the top of the perpendicular.

The upper ends of these two pieces of metal are joined together by a pin E, which perforates them and slides in the groove BC. The lower ends D, D of these pieces are slit, and passed over iron pins FF, in the sides of the base of the

machine, by which means the shortening of the oblique pieces or muscles can be represented; and as all the parts of the machine are divided into inches, 1, 2, 3, 4, 5, and parts of an inch, the decurtation of the pieces representing the oblique muscles can be accurately measured, and the motions can be shewn to correspond exactly with the demonstrations before given.

10.

Upon the whole, oblique muscles have the following effects.

1. Although the force of an oblique muscle is less than that of a straight one of the same number of fibres, in the proportion which the perpendicular bears to the length of the oblique fibre, yet oblique muscles, with short and numerous fibres, are employed where great strength is necessary, as in bending the fingers or toes; or where the part to be moved, the hand or the foot we shall suppose, resists with the advantage of a long lever against the muscles which serve for the flexion and extension of the elbow or knee; because, as a small degree of decurtation of the muscles is sufficient, short fibres will answer the purpose as well as long ones; and hence, as in such oblique muscles there may be many more fibres than in longer straight muscles occupying the same space, the oblique are preferred.

This resource of nature is so important, that on recollection you will find that there are more ob-

lique than straight muscles in the human body, and in the bodies perhaps of all other animals; or that in the greater number of muscles, the fleshy fibres are shorter than the direct length between the tendons at their extremities, or between the origins and insertions of the muscles. And the number of oblique muscles is still greater in fishes and aquatic animals, as a greater force is necessary to overcome the resistance of water than that of air.

2. When oblique muscles, consisting of the same number of fibres as straight muscles, are placed between two parallel lines, or between bones or other substances, which, when they are moved, remain parallel to each other, or nearly so, although their loss in strength be exactly in the proportion which their length bears to the direct distance between the parallel lines, yet we have found that they are capable of performing a much more extensive motion with the same proportional decurtation of fibres, or a motion of the same extent with less decurtation of fibres. Nay, that they are capable of bringing the parallel lines into contact with each other, which it is evidently impossible could be done by straight muscles.

The most striking instance of this kind is found in the intercostal muscles; for in this part of the body, nature, for the defence of the heart and lungs, forms the ribs as broad, and the spaces between them as narrow, as is consistent with their safety. Hence straight or perpendicular muscles

between the ribs would not have had sufficient length for producing the proper motion of the ribs; and we even find, that a great degree of their obliquity is required to produce sufficient motion.

In this part of the body we may remark another beautiful application of oblique muscles; for we find a second row of oblique intercostal muscles within the first, serving two material purposes, viz. In the *first* place, That this row compensates for the loss of strength the first row has suffered by its obliquity; and, in the *next* place, That the two rows conspiring, raise the ribs as directly upwards as could have been done by straight muscles, and press them as little forwards or backwards against their articulations as these would have done *.

In various other parts of the body, but particularly in the spine, where there are many joints, and the pieces of bone and intermediate cartilages are thin, straight muscles must have been so short, and their power of contraction so small, that they could not have produced a sufficient degree of motion in the joints of the spine; and hence we have found, that oblique muscles are very generally substituted instead of them.

3. As I have demonstrated that oblique muscles can perform the same extent of motion as straight

* This *latter* circumstance was distinctly remarked by Dr Mayow, De Respiratione, p. 247. and proved experimentally by Dr Haller.

ones, not only with a smaller proportional, but with a smaller actual decurtation of their fibres; and of course, that when they are contracted to the same proportional or actual degree, their motions are more extensive; we may observe in many cases, where an increase of strength is chiefly intended by the obliquity of the fibres of the muscles, that they are employed also for increasing the extent of motion. Thus, the upper and lower portions of the trapezius muscle, or the two lateral portions of the deltoid muscle co-operating, can produce more extensive motion of the scapula and of the humerus, than could be done by the middle portions of these muscles. In like manner, the external and internal oblique muscles of the abdomen co-operating, appear to be capable of bending the thorax forwards in as great a degree as can be done by the recti, although their fibres are considerably shorter.

4. As the oblique muscles can, with a smaller degree of decurtation, perform the same extent of motion as a straight one, it follows, that the same motions performed by them, will be executed in a shorter space of time than could have been executed by straight muscles of the same length, provided we take for granted, that the time in which the action of a muscle is completed, bears a proportion to the length of the muscle. To support in some measure this supposition, we may observe, that similar actions of small animals are completed sooner than those of larger; or if we compare the

action of the multifidus spinæ, which we may suppose to consist of as many short muscles as there are true vertebræ, with the action of a single straight muscle, supposed to reach from the os sacrum to the head, it is evident, that each of the several insertions of the multifidus spinæ would, in the same times, be moved through one twenty-fourth part only of the space through which the insertion of the single long muscle must pass; and therefore, unless we suppose the insertion of the long muscle to move twenty-four times more quickly than each of the insertions of the multifidus, it could not in the same time extend the trunk of the body to the same degree.

5. As the oblique muscles, in performing the same motions as straight muscles might perform, are less shortened than the straight would be, there is a saving of motion, and hence probably less fatigue.

6. Two oblique muscles, by balancing each other, may produce motions in a greater variety of directions than can be done by a pair of straight ones.

In the first place, by acting singly and alternately, they perform the offices of straight muscles, and draw alternately the place of their insertion directly towards its origins, which are generally more distant from each other than the origins of two straight muscles.

If, next, they co-operate with equal strength, the place of their insertion is moved in the dia-

gonal between them, as when the oblique muscles of the abdomen draw the ensiform cartilage towards the ossa pubis.

7. In the last place, each of them may act with different degrees of force, and hence move the place of their insertions in all the diagonal lines we may suppose to be drawn between them; or we may compare the pair of oblique muscles to the outer sticks of a spread fan, and the variety of the directions of the motions they are capable of producing, to the co-operations of intermediate sticks of the fan. In consequence of this motion in diagonal lines, the four recti muscles of the eye-ball enable us to follow an object moving before us in a circle.

APPENDIX,

In which the Assertion of a late author, Mr D. G. YEATES, *that "Dr* J. MAYOW *must be considered as the Discoverer of the important fact in Physiology, that Oblique Muscles possess the advantages of performing more extensive motions than Straight Muscles are capable of doing," is refuted.*

A late author, Mr D. G. YEATES, M. B. *, not contented with observing, that Dr J. MAYOW was the first who objected to the opinion which had been popular from the days of GALEN, That the external and internal intercostal muscles were antagonists to each other, and who endeavoured to prove that they co-operated, has ventured to allege, that "Dr MAYOW must be also considered as "the discoverer of the important fact in physiology, that "oblique muscles possess the advantages of performing "more extensive motions than straight muscles are capable of doing."

He pretends, "that the principle is clearly explained "by MAYOW;" though he is pleased to add, that "he is "by no means so prejudiced in favour of his author, as "not to admit, that Dr MONRO has very ably extended "the principle of obliquity to the action of the muscles "in general †."

* See his book, entitled, Observations on the Claims of the Moderns, 1798.

† Pages 184, and 185.

But, upon these assertions of Mr YEATES, I would observe, in the *first* place, That Dr HALLER, who had read, and quotes MAYOW's works, and who had considered the subject more fully than any other person of the present age, and by numerous experiments, chiefly on living animals, which I quoted in the Observations I published on the Muscles, p. 16., ascertained the fact, that the external and internal intercostal muscles co-operate in inspiration, (which I have since found, but did not then know, had been taught by Dr MAYOW, otherwise I should have quoted him along with Dr HALLER,) did not perceive in MAYOW, or in his own writings teach, any new principle throwing light on the general effects of oblique muscles, or tending to prove that oblique muscles possess the advantages of performing more extensive motions than straight muscles are capable of doing.

I shall next, as Mr YEATES proposes, allow Dr MAYOW to speak for himself in the following paragraphs, on which the claim for him rests.

In the Editio novissima of his "Opera omnia Medico-Physica, 1681, tractatibus quinque comprehensa," Tractatus Secundus, De Respiratione, p. 245., he states his arguments for his opinion, that the intercostal muscles, even the interior ones, serve for enlarging the chest: "Musculi intercostales etiam interiores pectori ampli-"ando inserviunt;" and in the next page, 246., he attempts to explain the reasons why the intercostal muscles have an oblique position, "Cur musculi intercostales "obliquam positionem habent," in the following words:

"Et hoc ulterius adhuc ostendit musculorum intercostalium obliquus, et contrarius situs. Ideo enim videtur natura musculos illos oblique costis inseruisse, *(quanquam iisdem sursum, aut deorsum movendis recta insertio melius*

conveniret), quia costarum interstitia adeò minuta sunt, ut si musculi isti rectis angulis insererentur, breviores essent, quàm ipsa musculorum natura patitur; quapropter ut dicti musculi justam longitudinem obtinerent, eos oblique, uti fit, costis insertos esse, oportet: cum tamen obliqua hæc positio ad costas sursum movendas minus idonea sit; ideò natura machinatrix sapientissima, diversi sitûs musculos constituit; ut, dum hinc inde æquali nixu oblique costas trahunt, costæ interea rectà sursum ascendant, prout in *Tab.* 2. *fig* 4. ostenditur: ubi musculis exterioribus *a a* et interioribus *c c* simul se contrahentibus, costa inferior, mobiliorque, non oblique, sed rectà sursum ascendat; perinde ac si à musculo, rectis angulis ei affixo, traheretur *."

Without any comment, I shall now appeal to the reader whether Dr Mayow has said any thing more than a person might have done who was entirely ignorant of geometrical principles, or of the advantages which co-operating muscles gain by their obliquity.

He rests the whole advantage of obliquity of the intercostal muscles on their being *longer* than *straight ones*

* "The oblique and contrary situation of the intercostal muscles shows this still farther. For although a straight insertion would suit better for moving the ribs upwards or downwards, yet Nature seems to have inserted them obliquely into the ribs, because the interstices of the ribs are so minute, that if these muscles were inserted at right angles, they would be shorter than the nature of muscles suffers; wherefore, that the said muscles might obtain a just length, it was necessary to insert them, as is done, obliquely into the ribs. But as this oblique position is less fit for moving the ribs upwards, therefore Nature, a most wise contriver, hath disposed these muscles in different situations, that whilst with an equal effort they draw the ribs obliquely here and there, the ribs in the mean time ascend straight upwards, as is shewn in Tab. 2. fig. 4., where the external muscles *a a*, and the internal *c c* contracting themselves at the same time, the inferior and more moveable rib will ascend, not obliquely, but straight, as if it were dragged by a muscle fixed to it at right angles."

between the same parallels, without attempting to prove, or suggesting, that oblique muscles, placed between the same parallels with straight ones, could, with a smaller decurtation, perform as extensive motion as straight ones; or that, with the same decurtation, they could perform more extensive motions; or that from their obliquity they derived any other advantage than that of being *longer*. And he was so far from having the most distant conception that oblique muscles could perform more extensive motions than straight ones of the same length, that, in the passage above quoted, he affirms the direct contrary. "*Ideo enim videtur musculos illos oblique costis inseruisse, quanquam iisdem sursum aut deorsum movendis recta insertio melius conveniret.*"

What new principle, then, is Dr Mayow supposed to have discovered with regard to the effects of oblique muscles?

But not to rest here, I shall proceed to shew, by quotations from his own works, the inconsistency of Dr Mayow with himself, and to prove undeniably, that he not only did *not discover*, but did not even *suspect* that oblique muscles could perform more extensive motions than straight muscles placed between the same parallels. The reader will find the proof of what I here allege, in the subsequent Chapter II. of Mayow, which I have reprinted below at full length, from the Opera Omnia Medico-Physica of J. Mayow in 1681.

"CAP. II.

"*Musculorum brevis Descriptio. Item quænam Pars Musculi primario contrahitur.*

De Fibris carneis musculi.

"In musculorum anatomicâ dissectione primò se conspiciendum offert integumentum membranaceum, mus-

culo cuivis quaquaversus obtensum; sub quo in conspectum veniunt Fibrarum carnearum series; quæ tendinibus oppositis, et parallelis, ipsæ etiam parallelæ cum angulis obliquis inseruntur. Prout à *Cl. D. Stenone* primò animadversum est.

Fibrillarum descriptio.

" Porrò observare est Fibrillarum Membranacearum, pene infinitarum admirandas series quæ inter se parallelæ, fibras carneas transversim, sed obliquis angulis secant: nempe eodem modo, quo Fibræ carneæ tendinibus, etiam Fibrillæ fibris carneis, situ tamen opposito, inseruntur: Et sicut Fibræ arcte conjunctæ Tendines, ita Fibrillarum collectio ex parte saltem aliquâ ipsas fibras componere videtur. Uti in *Fig.* 2. *Tab.* 3. apparet, quæ Fibrarum, et Fibrillarum series exhibet, quatenùs in musculis diu satis coctis conspiciuntur.

Eædem primario contractionem ineunt ex authoris sententiâ.

" Hactenus Fibras carneas musculi præcipue, et primario contractionem inire, ab Authoribus in re anatomicâ versatissimis statutum est: ex nostra autem opinione (quod eorum pace dictum velim) non Fibræ, sed Fibrillæ, transversum iisdem insertæ, præcipuas in contractione musculari partes obtinent, id quod ex indiciis saltem probabilibus colligimus. Etenim si contractio in fibris carneis fieret, tunc ad debitam musculi contractionem necesse erit, ut Fibræ multo magis quàm ipse Musculus in longitudine abbrevientur; cùm enim fibræ non secundum musculi longitudinem disponantur, sed oblique tendinibus inserantur, prout in prædictâ figura videre est, hinc fit, quòd musculi contractio fibrarum contractione multò minor sit; et ad justam musculi contractionem requiratur, ut fibræ multo magis quàm ipse musculus contrahantur: tantam autem fibrarum contractionem revera in motu dari non existimo: præterquam enim quod in vivisectionibus fibrarum hujusmodi contractionem conspicere non licet: si fibræ carneæ in tantùm contraherentur,

Fibrarum situs obliquus musculi contractioni minus convenit.

muscu lu minimmensum excrescere oporteret, quod tamen non contingit.

At fibrillarum positio recta eidem perficiendo idonea est.

" Cæterùm ut musculi contractio à Fibrillis perficiatur, tanta earum contractione, et intumescentia minime opus erit; utpote quarum series, ut in figura dicta manifestum est, secundum musculi longitudinem disponuntur, ita ut musculi contractio fibrillarum contractioni æqualis fuerit. Jam verò cum naturæ mos sit via maxime compendiaria uti; probabile est musculi contractionem potiùs per Fibrillarum, quàm Fibrarum contractionem fieri. Huc etiam facit quòd, cum fibrillæ minutissimæ brevissimæque sint, earum contractio etiam ad dimidias, vix quidem notabilis erit: Etenim dum Fibrillæ universim contractionem patiuntur, res haud secus habet, ac si fibræ secundum musculi longitudinem extensæ, in varias corrugationes cogerentur, cujusmodi quidem earum contractio, utcunque satis magna, sine notabili tamen musculi intumescentia fieri post.

Fibrillæ musculi constrictioni conveniunt.

" Quibus insuper addo, quòd fibrillæ abbreviatæ fibras carneas ad invicem adducant, et constringant; ita ut probabile sit musculorum contractionem ab iis perfici; siquidem musculus contractus insigniter constringitur, et durescit; id quod nulla alia ratione, quàm fibrillarum contractione fieri posse videtur. Verùm de musculi contracti constrictione infrà fusius dicetur.

" Ad hæc, naturæ consuetudo talis est, ut operationes suas minimorum ope plerunque perficiat; ita ut fibræ nimis crassæ, rudesque esse videantur, quàm ut contractio muscularis in iis primario fiat; easque potius sanguini trajiciendo, quàm motui animali perficiendo inservire probabile est, uti infra ostenditur.

Uti etiam ejusdem robori.

" Denique et huc spectat, quòd fibrillarum brevitas, numerusque pene infinitus, ad musculorum robur, eorumque tractionem validius perficiendam conducit. Plane ut

fabrillæ sive earum numerum, seu magnitudinem, seu denique situm perpendimus, contractioni musculari instituendæ multo, quàm fibræ carneæ aptiores videantur. Id quod insuper ex ipsa autopsiâ magis adhuc confirmatur; quantum enim in Vivisectionibus inspiciendo assequi unquàm potui, fibræ carneæ in musculi contractione, tanquam à fibrillis transversis attractæ, propius ad invicem accedere; et non ipsæ abbreviari, sed fibrillarum contractionem sequi videntur.

Cur fibrâ in utroque termino ligatâ musculus contractionem inire nequit.

"Quòd verò ob ligaturam utrique fibrarum carnearum extremitati injectam, muscularis contractio cessat, fibraque ipsa non uti aliàs in tumorem assurgit, uti à *Cl. D. D. Willisio* annotatum est, hoc propterea fieri existimo quòd sanguinis, Spirituumque Animalium motus, per ligaturas injectas interrumpitur, quorum tamen influxus ad fibrillarum contractionem necessarius est."

In the above chapter, the reader will observe that he describes a muscle as composed of *fleshy fibres*, and of an almost infinite series of *membranaceous fibrillæ*, (which last have been called by all modern anatomists, threads of the cellular substance.)

He tells us, that hitherto it has been maintained by authors, that the contraction of a muscle is primarily performed by its fleshy fibres, but that, in his opinion, not the *fleshy fibres*, but the *fibrils* inserted *transversely* into the fleshy fibres, perform the chief part in muscular contraction, and that the *straight position* of these fibres is fit for performing it. To which he adds, that the *fibrils*, when shortened, draw the *fleshy fibres* towards each other, so that it is probable that the contraction of muscles is performed by them, seeing that a contracted muscle is remarkably constricted and hardened, which can be no other way done than by the contraction of the *fibrils*;

that the *fleshy fibres* seem to be too thick and rude for performing primarily muscular contraction, and that they rather serve for transmitting the blood, than for accomplishing animal motion.

In fine, that the shortness of the *fibrils*, and their almost infinite number, conduce to the strength of muscles; so that plainly, whether we weigh the number of the *fibrils*, or their magnitude, or their *situation*, they seem much fitter for muscular contraction than the *fleshy fibres*. This is moreover confirmed by ocular inspection; for that, so far as he could ever observe in dissecting living animals, the *fleshy fibres*, as if dragged by the *transverse fibrils*, approached each other, and were not themselves shortened, but seemed to follow the contraction of the *fibrils*.

He prints on the margin of p. 302. the heads of the contents of this page in the following words: "Fibra- "rum situs obliquus musculi contractioni *minus* convenit, "at *fibrillarum positio recta* eidem perficiendo idonea "est." He delineates in his figure 2d of Table 3., which is exactly copied in Plate 3. fig. 10. of this dissertation, a semipenniform muscle, in which the fleshy fibres *ccccc* are represented as passing obliquely from the tendon A on one side of the semipenniform muscle, to the tendon B on the other side of it; and his *fibrillæ membranaceæ*, *d d d d*, are painted and described as passing transversely from one of the *fleshy fibres* to another, by which his *fibrils* are delineated as being parallel with the tendons on the sides of the muscle, or as running in straight and parallel lines from the one end of the muscle to the other. "Et "sicut fibræ arcte conjunctæ tendines, ita fibrillarum "collectio, ex parte saltem aliqua ipsas fibras componere "videtur, uti in fig. 2. Tab. 3. apparet."—See the copy of Mayow's figure in Plate 3. fig. 10.

If, therefore, instead of delineating a semipenniform muscle, he had delineated in the same manner a portion of the two rows of intercostal muscles, the *fleshy fibres* would have appeared to run from one rib to another in the oblique direction; but his *fibrillæ membranaceæ* would, consistently with his general description of a muscle, have been represented as running straight or perpendicularly from one rib to another; so that if we adopt Dr Mayow's doctrine in Cap. II., we should conclude that the motion of the ribs is primarily, chiefly or solely, performed by membranaceous fibrils or threads of cellular substance, passing straight, perpendicularly, or at right angles from one rib to another; or he retracts, and directly contradicts what he had before taught of the effect of the obliquity of the fibres of the intercostal muscles.

It is therefore proved undeniably, and very evidently, by mere quotations from his own book, that Dr Mayow was inconsistent with himself, and had no title whatsoever to be considered "as the discoverer of the important "fact in physiology," as Mr Yeates calls it, "that "oblique muscles possess the advantages of performing "more extensive motions than straight muscles are ca-"pable of doing."

It of course follows, that Mr Yeates, and certain other persons, who have ascribed this discovery to Dr Mayow, had either not read his book with proper attention, or had misunderstood it, or had misrepresented it.

Antagonist Muscles.

In a former page, it was observed that there were antagonist muscles, Flexor and Extensor muscles, which act by an opposite pull.

Such a disposition of the muscles is conducive not only to the reciprocal energetic motion of the limbs, but also to their symmetry.

Thus, after the flexor muscles of the fore-arm have bent it, the extensor muscles act, and extend and straighten it.

The flexor muscles are generally stronger than the extensors, owing to their fibres being more numerous, and to their being inserted further from the centre of motion: hence, during sleep, the limbs are generally somewhat bent.

Velocity of Muscular Action.

The velocity and precision of muscular action are very remarkable, and of these there are many striking examples, as in speaking, writing, running, &c.

Effect of Custom on Muscular Action.

Custom exercises its sway over the muscles. The bladder of urine affords an example of the effects of custom: some persons retain a large quantity of urine in it, but others have a call to make water when it contains only a few ounces of urine.

Effects of Imitation and Sympathy upon Muscular Action.

Imitation is a very useful agent in instructing us in performing many actions.

Thus, the child learns to speak, use its limbs, &c. In early life, it is equally independent of reason and reflection, and even takes place in direct opposition to the will, as in yawning.

All those actions which are necessary for life, as sucking, swallowing, or crying, a child performs accurately as soon it is born; but others, which are less necessary, it gains by practice, or by being taught.

By *Sympathy* particular muscles are called into action: thus, the sight of disagreeable objects produces the expression of horror, and sometimes excites vomiting; and perhaps, owing to this principle, hysteria and epilepsy are propagated from one person to another.

Effects of Passions of the Mind on Muscular Action.

The different passions of the mind naturally call into action certain muscles, and the predominant passion implants upon the countenance a corresponding indelible impression, though the mind is not at the instant under the in-

fluence of that particular passion: hence, those of the same profession generally acquire the same character of countenance. Upon this the science of physiognomy is built. Not only the muscles of the face, but also those of other parts of the body are thrown into actions corresponding with the ruling passions of the mind.

The attitude of the body is perhaps equally characteristic of particular passions as the expression of the countenance. To this the painter must devote particular attention, that the attitude of his figure be consonant with the expression of the face.

Vid. Many other observations upon muscular action under the head of Functions of the Nervous System.

Authors on the Structure and Action of Muscles.

Gottsched, Anat. de Muscul. Haffniæ, 1664.
Muys, Muscul. artific. fabrica, Leyd. 1741.
Winslow, Traité des Muscles.
Albini, Historia Muscul.
Prochaska, De Carne Musculari, Viennæ, 1778.
Borelli, De Motu Musculorum.
Stuart's Lectures on Muscular Motion.
Croonian Lectures; London Phil. Trans.
Blane's Lecture on Muscles.
Barthez on the Mechanism of the Muscles.
Monro on the Oblique Muscles; Edin. Phil. Trans.
Barclay on Muscular Motion.
Galvani, Fowler, Pfaff, Creve, Humboldt, Davy, and Monro on Galvanism; Edin. Phil. Trans.

Representations of the Muscles dissected.

The Tables of VESALIUS, EUSTACHIUS and ALBINUS, well merit particular attention and praise.

Muscles in Action.

The antique statues, and particularly the Group of the Laocoon, the Fighting Gladiator, the Boxers, afford by far the best examples of muscular exertion.

LANCISI, in his "Anatomia per uso et intelligenza del designo," published 1691, has given several good representations of the muscles which are thrown into action in the principal figure in the *group of the Laocoon*, and also those of the *Fighting Gladiator*.

The celebrated statue, the *Dying Gladiator*, gives a beautiful representation of the muscles of the body in a state of relaxation.

There are many of the statues and fresco paintings of MICHAEL ANGELO, which also afford very accurate views of the muscles; for his anatomical knowledge, as CONDIVI has observed, "was so correct, that those who had all their "lives studied it as their profession, hardly understood "it so well *."

In the celebrated cartoon of MICHAEL ANGELO, *of the Soldiers alarmed whilst bathing in the Arno*, there is a wonderful display of anatomical knowledge in the attitudes of the several figures.

A very excellent print from the above cartoon has been lately engraved by LUGO SCHIAVONETTI.

* Vid. DUPPAS's Life of Michael Angelo, 1st edit. p. 165.

In the engravings by Bartolozzi *, after the drawings of Leonardo da Vinci, in his Majesty's collection, there are many good views of the bones, and also of the muscles.

CHAPTER VII.

GENERAL OBSERVATIONS ON THE BURSÆ MUCOSÆ, VESICÆ UNGUINOSÆ, OR BURSÆ SYNOVIALES.

The term *Bursa Mucosa* was applied by Albinus to certain shut sacs, which he discovered placed under the tendons of the muscles. Albinus has enumerated only 16 pairs of these, not being aware that tendons within sheaths were provided with similar, but oblong-shaped bursæ. My Father discovered many of the bursæ, and has described, in his Treatise on these shut sacs, 140 of them.

The bursæ mucosæ are of different sizes, and are interposed between such parts as rub violently upon each other. They are connected by cellular substance to the capsular ligaments, muscles, and their tendons, in such a manner as to lessen the effect of attrition.

* Published by Mr Chamberlaine.

1*st*, The bursæ are situated between bones,—as between the clavicle and coracoid processes of the scapula.

2*d*, Between bone and ligaments,—as between the acromion and ligaments of the humerus.

3*d*, Between tendon and ligament,—as between the tendon of the psoas, iliacus internus, and ligament of the hip-joint.

4*th*, Between two tendons,—as between the tendons of the extensores carpi, longior and brevior.

5*th*, Between tendon and its sheath,—as within the sheaths of the tendons of the fingers and toes.

6*th*, Between tendon and cartilage,—as between the tendon of the superior oblique muscle of the eye, and its cartilaginous pulley.

7*th*, Between tendon and bone,—as between the tendon of the scapulo-radialis muscle and radius, &c.

The bursæ are larger in the extremities than in the trunk of the body, and are either of a rounded or oval shape, or somewhat like purses, including the sheaths of the tendons: hence the bursæ have been arranged under two great classes, the *Spherical* and the *Vaginal Bursæ*

The bursæ mucosæ of children are proportionally larger than those of the adult.

The proper membranes of the bursæ, though remarkably thin, are capable of confining fluids, and even air, and, according to my Father, are in structure similar to the internal layer of the *capsular ligaments of the joints, to the pleura, periosteum,*

and other serous membranes, and consequently subject to the same organic derangements *.

The membranes of the bursæ are united to the neighbouring parts by the common cellular membrane, and where situated in the vicinity of the bones, a thin layer of cartilage is interposed between the bursa and the bone.

The membrane of the bursa is internally remarkably smooth, and lubricated by *a fluid in all respects similar* † to synovia, and there are very small masses of fat within the bursa, with fringes appended to them, which are covered by the continuation of the membrane of the bursa, and upon which the smaller ramifications of the arteries are distributed in considerable number, which thereby communicate to it a pale red colour.

Lymphatic Vessels.

Lymphatic vessels certainly exist in the bursæ, though so small as to elude observation.

1*st*, If the bursæ mucosæ had not been provided with lymphatic vessels, they must have become dropsical, and must have been ruptured by the quantity of fluid accumulated within them.

2*dly*, Fluids of different descriptions, which are occasionally collected within the bursæ, are also sometimes resumed.

* In this observation he has anticipated BICHAT.

† Vid. Pages 78. and 79.

Nerves.

On account of the extreme thinness of the coats of the bursæ mucosæ, the anatomist cannot give ocular proof of nerves being distributed upon their coats, which has given rise to the opinion that the bursæ mucosæ are not supplied with nerves, which opinion, as the bursæ are endowed with little sensibility, has gained weight. But as an inflammation of the bursæ occasions great pain, there can be no doubt *of their being under the influence of nerves.*

Authors upon the Bursæ Mucosæ.

Winslow, Exposit. Tr. des Os frais, 286.
B. S. Albinus, vid. Histor. Muscul. 4to, 1754. p. 694.
Sandifort, Descr. Mus. Hominis, 1781.
Monro's Description of all the Bursæ Mucosæ of the Human Body, fol. Edin. 1788.

Professor Soemmering, one of the most distinguished anatomists of Germany, has stated his opinion of this last book in the following terms: "Omnium optimum opus, icones descriptarum bursarum magnitudine naturali, ut uno quasi intuitu earum positus, figura et magnitudo comprehendi possint, quod sola descriptione nunquam effici potest."—Vid. Catalogue of Authors, prefixed to the third volume of his Anatomy.

CHAPTER VIII.

GENERAL OBSERVATIONS UPON THE INJURIES AND ORGANIC DISEASES OF BONES.

THE bones are much exposed to external injury: they are frequently bruised, cut, displaced, or broken.

The bones are also subject to several organic derangements, which, as Dr BOERHAAVE has justly remarked, are similar to those of the softer organs: "*Ipsa ossa morbos patiuntur similes iis, quos hactenus in mollioribus partibus descripsimus* *."

The bones inflame, swell, suppurate, and become gangrenous.

The organic diseases of the bones are less rapid in their progress than those of the softer parts, which has been imputed to the quantity of earth which enters into their composition: thus, a wound of the softer parts is healed (when properly treated) in two or three days; but a broken bone does not re-unite for two or three weeks, and the rapidity of the re-union has been stated to bear a ratio to

* Aphor. 512.

the age of the individual, the broken ends of the bones of the young being more rapidly rejoined than those of the old.

Inflammation of Bones.

Bones are frequently inflamed; and when reduced to that state, like the softer parts, acquire an unnatural redness, which is often visible beneath abscesses of bones.

Swelling of Bone.

A swelling, or exostosis of the bones is generally a partial disease.

Some exostoses appear at a very early period of life, and without an evident cause, and become gradually larger: others seem to originate from *external violence; others from scrofula, lues venerea, or cancer.*

Exostoses differ as to size, situation, consistence, and sensibility.

There exists in some constitutions a very strong disposition to the formation of exostoses. I have seen these growing *from almost every bone in the body,* and of a large size, and irregular figure, and in the direction of some of the muscles, and in process of time all the joints became rigid.

Such exostoses, in some cases, appear at different periods of life, and in succession.

The scrofulous exostoses, which sometimes attain a large size, are most frequent in the bones of the *spine, of the tarsus, carpus, and in the bones forming the hip and knee joints;* whereas the venereal exostoses appear most frequently in the *middle and most compact part of the tibia, humerus, ulna, or in the os frontis, and ossa parietalia.*

Exostoses generally grow outwardly, but sometimes, though much more rarely, *inwardly*, so as to press much upon the brain, the viscera of the thorax or pelvis.

The structure of exostoses is evidently different from that of the original bone *.

Some exostoses, when divided, are found to be made up of a thin outer plate of bone, to which thin osseous plates are connected, which pass across the tumor, and the interstices between these are filled up by cartilage; and in others, beside a gristly substance, there are fungous granulations, and a quantity of ill-conditioned pus. Such exostoses often attain a large bulk, and are very irregular in figure. Vid. Plate 6.

Some exostoses are made up of a number of small fibres, which, as to their disposition, are not unlike those in the roots of some trees in a state of decay.

Other exostoses consist of solid bone, which is as dense as ivory, and these are generally of a small size, of a round, or oval shape, and very hard to the touch.

* Vid. Plate 6.

There are some exostoses which speedily degenerate into caries, viz. The cancerous and venereal; but there are others which remain stationary for years, and indeed the ivory exostoses have never been observed to pass on to the state of caries.

Abscess and Caries of Bones.

Abscess sometimes gives rise to caries, and is the result of wounds, of fractures, lues venerea, cancer *, and scrofula.

Exostoses frequently degenerate into caries, and the exostoses are in many instances in the first place destroyed.

Ulcers of the bones bear *a strong resemblance to those of the softer organs*, from the effect of the same organic derangement, and occur generally in the most spongy bones, *as the vertebræ, bones of the tarsus, and extremities of the long bones.*

The ill-conditioned fetid matter, the concomitant of caries of the bones, generally makes its way outwardly, at small fistulous orifices, and these are filled by fungous flesh, which bleeds when slightly touched.

When carious bones are probed, they communicate a gritty sensation, and are sometimes so soft that the probe sticks in them.

When a caries of a joint has existed for a long time, an external suppuration generally takes place,

* Vid. Plate 7.

if the hip-joint be the seat of the disease, below the great trochanter, over the vastus externus muscle, and sometimes at the anterior part of the thigh, frequently on the nates, or higher up in the loins, and often in all these parts successively.

Mr FORD has observed, " that the efforts of Nature towards the cure of a diseased bone, are more easily assisted, and proceed with more certainty when external suppuration has not been encouraged; where air is not admitted; and where the strength of constitution is supported by generous diet."

Spina Ventosa.

" This is a disease either not known by the ancient Greek or Roman writers, on Physic, or described by them under the general name of Caries. It was first fully described by the Arabians, particularly by RHAZES, under some Arabic name, which has been translated spina ventosa, or spinæ ventositas, from the pain, say some *, being as sharp as a puncture of the spinal marrow, and wandering like a windy tumor. I rather think the name has been taken from the appearance of the diseased part; for after the side of the bone is eroded, there are a number of sharp points or spines standing out from the sides of the external aperture; within these is a large cavity, containing nothing

* Vid. PANDOLPH, Cap. I.

except a thin covering of spongy flesh; so that the Arabians might have imagined the bone to have been *distended with air*, from which and the spines *the name was given.*

" The common progress of this disease is in the following manner. Children of a weakly constitution, or old people under scurvy or pox, complain of some uneasiness, which they do not well know how to describe, in bones that are not covered with thick muscles, such as those of the *fore-arm, hand, leg, foot, cranium, or face.* After some time, pain is caused if the diseased part is pressed hard. Swelling and thickness of the bone are afterwards observed, and the teguments covering it become softer and thicker. This thickness of bone and teguments increasing, the part becomes more sensible and red. Too often hectic fever comes on, with all its train of colliquations, and the patient gradually is exhausted, if convulsions or apoplexy coming towards the end do not abridge his life.

" When the bones affected with this disease are examined, the periosteum is found separated, except at the joints, or union of epiphyses with the bone, and *the bones are thicker, more spongy* and porous than natural. Some are perforated *by holes* through them, as if they were worm-eaten.

In other bones there are *great cavities, with few or no cancelli; the sides of the bones break off unequally, leaving sharp points.*

" There can be no regular exfoliation, which is only caused by suppuration between the sound

and corrupted parts of a bone. There is a skeleton in the Museum, in which the *os frontis, lower jaw, upper ends of the radius and ulna, have a great opening, with sharp points at the edges, and a much larger cavity which had nothing but a small quantity of soft spongy flesh in it when recent. The lower end of the radius is much swelled, and several large holes are in it. The metacarpal bones are in a similar state* *.

" The irritation in the internal parts raises some degree of inflammation in the external ones, and the ichor penetrating the periosteum, diffuses itself in the cellular membranes, which causes thickness and pappiness in the teguments. The extravasated liquor continuing to erode the parts containing it increases in quantity, and forms a fluctuating collection under the skin, which being fretted, inflames more and more, so as to become of a more intense colour.

" The skin yields to the pressure of the contained liquor; the acrid matter bursts forth at different places through the orifices.

" This matter not being produced by a kindly inflammatory suppuration, is thin and watery like whey, with some pieces of undissolved cellular membrane swimming in it; it gradually wastes the sides of the orifice of the skin, and enlarges it, to make at last a large one, from which there is a constant discharge of a watery ichor, which has little fœtor.

* Vid. Plate 8.

"The flesh rising from such a spongy root is very soft, and of such a tender texture as to be easily lacerated, and frequently pours out blood.

"The patient becomes atrophic and weak.

"With regard to the prognosis, the more the cause of this disease is rooted in the constitution, by its being hereditary, or ingrafted by a nurse, the more dangerous it is.

"The greater progress, or more universal attack the disease has made on the bone, the worse it is to cure.

"The more advanced the hectic fever is, the danger is greater.

"In children, the earlier it begins so much the worse, for such are longer of obtaining the vis vitæ necessary to conquer it. When the spina ventosa depends on pox or scurvy in adults, this disease must be forced out of the blood, by the remedies proper to each, and the topical management is the same as for caries occasioned by other matter lodged within a bone.

"When children have it, they are to be strengthened, for I never saw any benefit from the common specifics, Æthops mineral, cinnabar, &c. and the salivating preparations of mercury, have a bad effect; they bring the patients soon to their grave, by bringing on the hectic fever, with its colloquations. Purgatives frequently given produce the same bad effects *."

* The above Observations on Spina Ventosa are printed verbatim from a Manuscript of my Grandfather.

Gangrene of Bone.

By gangrene, a bone becomes of an opaque white colour, brown, or black.

The gangrene is frequently limited to the outer tables of the bones, which are cast off by what has been named *the process of exfoliation*, but in other instances, it extends through the greater part of the bone, and then also is cast off, and the place of the dead bone is in many cases supplied by a new growth of bone around the dead part. The dead portion of bone, or *sequestra, as it has been called*, is for a time included in the new formed bone. At length it protrudes, forming generally an acute angle with the new formed bone. In time, the dead portion of bone gradually becomes looser, in consequence of being in part absorbed, and at length it falls out, either as an entire cylinder, or in the form of a number of sharp spiculæ *. In the young, the old bone is sometimes absorbed, and no part is discharged externally.

The new bony case sometimes so completely fills up the space of the dead bone, that although the tibia be the seat of the disease, *many patients have been able to walk during the whole progress of the disease.*

But in some cases, the deposition of the new bone *does not keep pace* with the destruction of the original bone, and such patients lose the use of the affected member.

* Vid. Plate 9.

It may be proper to observe, respecting the new formed bone, that it is at first ill-shaped, irregular on its surface, whiter, less dense than the old bone, and its laminæ are scarcely visible; and as it is formed upon the old bone, it must be larger than it.

To this form of gangrene of bones, the term *Necrosis has been commonly, but improperly applied*, as it is equally descriptive of gangrene of the softer parts.

The *necrosis* is most frequent in the middle of such bones as are but slightly covered, as of *the lower jaw**, *the tibia**, *os humeris, clavicles*, and seldom or never extends to the extremities of the bones.

The disease is generally limited to *one bone;* but I have sometimes seen it attack *various bones* of the same child in succession, of which I shewed a remarkable instance to Dr MACDONALD, who has made mention of it in his thesis *De Callo et Necrosi* †.

This disease has been frequently occasioned by fractures of the bones, and it has been artificially produced by TROJA, by destroying the marrow of the bones of animals.

I have made many experiments of a similar description with those of TROJA, but *did not always*

* Vid. Plates 9. and 10.

† Vid. Page 22. of Thesis.

induce the disease; and there are three preparations of necrosis in the Museum of the University, which distinctly prove * that necrosis may take place *though the marrow be in a sound state;* for in these very beautiful preparations, the vessels of the marrow have been very successfully filled, and it appears to be in a sound state.

Of an Excess of Earthy Matter in Bones.

The bones sometimes attain an unnatural size, in consequence of an excess of bony matter, which is deposited, not only upon the outer, but also on the inner surface of the original bone.

Plate 11. exhibits a remarkable instance of this disease in the thigh-bone, the cellular substance of which had been filled up by earth, and the diameter of the medullary canal was much less than common.

On the Diseases originating from a Defect of the usual proportions of Earthy Matter in the Bones.

When bones do not contain a due proportion of bony matter, instead of protecting the softer organs, they sometimes are protruded inwards, and make pressure upon the contained bowels, thereby deranging their functions.

* Vid. Engravings of these in Dr MACDONALD'S Thesis De Necrosi et Callo, Plates V. and VI. which also give a good idea of the state of the softer parts.

Rickets, mollities ossium, and *osteo-sarcoma,* have been commonly considered as different diseases, whereas it is probable that they are only *degrees of the same morbid derangement;* and these different names should be retained, to express the degree of softening of the bone, and the period of life at which it has taken place. Thus, rickets is a disease of infancy; mollities, of advanced life; and in the latter, the softness of the bones is much greater than in the former.

In some cases, only *one* of the bones, but in other instances, *the greater number of bones* of the skeleton are affected.

In early life, I have seen the disease limited to the *spine,* to the *breast-bone,* or to the *ribs,* occasioning a manifest depression in these.

The rickety skeleton presents the following appearances.

The bones are crooked, and in many cases flattened, and considerably broader than in the sound state.

The skull is generally unnaturally large, owing either to the preternatural extension of the diploe, (Vid. Plate 12.), or to the disunion of the bones of the skull, in consequence of water accumulated within the ventricles of the brain.

The thorax is sharper before, and more depressed at its sides.

The cartilages of the ribs, instead of being convex outwardly, become concave, and on many occasions, there are hard osseous tumors at the

junctions of the cartilages with the osseous parts of the ribs.

The scapulæ are raised higher than usual, and at last almost touch the head. The disease is often limited to the spine, which, becoming crooked, generally acquires a second curvature, and in an opposite direction.

When the cervical vertebræ become crooked, the head falls back, and seems sunk between the shoulders.

When the disease appears during infancy, the bones of the pelvis are frequently distorted, the sacrum approaching the pubis.

The thigh-bones are bent forwards, and the neck of the thigh-bone, instead of being oblique in respect to the shaft of the bone, forms a right angle with it, and the ends of the bones are enlarged.

The bones of the leg are bent in a similar manner with the thigh-bone.

It may be proper to add, that the bones of some rickety children contain so *very little* earth, that when steeped in water for some time, they are resolved into a pulpy matter; and they shrink by drying, very considerably, both in length and thickness. When, on the other hand, the bones from rickets have attained an unnatural thickness, then, *though softer than natural, they contain more earth than the same bone in its healthy state,* as has been clearly proved by the very accurate chemical analyses of Mr JOHN DAVY. Vid. *suprà,* pages 37 and 38.

Incarnation of Bone, or Osteo-Sarcoma.

Incarnation of bones has a great resemblance to rickets. Du Verney has described two cases in which incarnation of bones took place in those who had been rickety when young.

This disease appears to me to be only a more severe species of rickets, the bones being so much softened as to bear some resemblance to flesh; hence the name.

The bone is sometimes converted into a *soft lardy looking substance;* at other times there is a large tumor, filled by fungous flesh, and which is covered by a thin compact shell of bone, which is often perforated by various holes.

This disease has been described by different authors, by Marcus Severinus, *De recondita Abscessûs natura*, edit. de Leyd. I met with a case of it which I think worthy of insertion in a note, the disease being very rare *.

* "A—— M—— æt. 21.

"Extending from the scapula along the shoulder, and down to the elbow of the left arm, is a tumor of a very great size, about twenty-eight inches in circumference at its thickest part, including the arm. It appears to be firmly attached to that half of the scapula next the arm, and also to the pectoral muscle. The patient can move the shoulder upwards, but, on account of the weight of the tumor, this is performed

Bones converted into a substance like Chalk.

The extremities of the bones of the feet and hands have been said to be occasionally converted into a white substance like chalk, in persons who have long been afflicted by gout.

with difficulty. The tumor is very unequal on its surface, has a firm feel, and in some places is even hard to the touch; the anterior part is covered by a number of veins, very much enlarged, and the integuments covering it possess nearly their natural appearance, excepting on its most elevated points, where they are somewhat of a red colour, and the tumor there feels softer than in any other of its parts. Nearly half way between the shoulder and elbow, on the anterior part, the integuments have burst, and through the opening there protrudes a fungus, somewhat larger in size than an egg, of a red colour, discharging from its surface a yellowish coloured pus, and upon the least touch this fungus is frequently observed to discharge a considerable quantity of blood. In the whole tumor there is sense of heat, and an acute lancinating pain, shooting towards the fungus above mentioned. About twelve-months ago, a small, hard, very painful tumor made its appearance on the top of the shoulder, which has since gradually increased to its present size.

" The tumor has been opened several times with a lancet, by which nothing was evacuated except a quantity of pure blood.

" He is much emaciated: pulse full, quick and soft; and from the weight and size of the tumor, he turns himself in the bed with great difficulty.

" Dis-

Mollities Ossium.

The Mollities Ossium has been described as a primary disease; but I believe it to be more frequently symptomatic. I have a preparation of the knee-joint of a young woman whose limb was amputated on account of a white swelling, the bones of which were so soft, that I divided them with a scalpel, without turning the edge of it.

The bones of the foot are sometimes reduced to a similar state by scrofula; and I have seen the middle of the humerus as flexible as thick leather which had been steeped in water for some time, which is supposed by some to be the effect of cancer, by others of the osteo-sarcoma. The disease is therefore sometimes symptomatic, and peculiar to some bones of the body only: on other occasions, it has been described as a general disease.

"DISSECTION.

"On making an incision through the integuments, which were every where extremely thin, and on dividing the tumor from one extremity to the other, it was found to be composed of a substance very much resembling bony callus; but in many places, the tumor was of a solid texture, and could not be divided but by a saw. The cells of this callus-like substance were filled with matter somewhat of the consistence of soft cheese. The tumor adhered every where strongly to the outside of the os humeri, which was completely diseased from one extremity to the other, and somewhat enlarged. The upper part of the tumor seemed also attached to the acromion process of the scapula, as well as to the distant extremity of the clavicle, and there was moreover a complete anchylosis of the shoulder-joint.

Mollities ossium is sometimes the effect of lues venerea.

Mr SALLE relates the case of a woman who was seized with mollities after two mercurial courses; the bones became extremely soft *.

* Mr BEVAN, in the Phil. Trans. 1752, 43. N. 470. relates the case of a woman, who at the age of thirty-six was seized with frequent copious discharges of urine.

This was attended by gradual emaciation, hectic, quick low pulse, thirst, and great pain in the shoulders, back and limbs.

Eighteen months before her death, she had such weakness and pain in her limbs as to be confined to bed.

The bones of her arms and legs felt soft to the touch for many months before her death, and bent freely in all directions.

On dissection, the membrana adiposa was found thicker than could have been expected in one so emaciated.

The sternum and ribs were very soft.

The lungs adhered closely to the ribs for four or five inches on each side. The liver was one-third larger than natural, and also the spleen.

There were appearances of anchylosis having been formed about the joints of the carpal and metacarpal bones.

The bones were soft and membranous, and contained a fluid of the consistence of honey.

There were no appearances of any bones in her legs or arms, except near the joints, and these parts were very soft, and very full of holes like a honeycomb.

A remarkable instance of this kind occurred in Paris, in the person of Madame SUPIOT.

This woman was attacked by the disorder when thirty-three years of age.

The disease began by a febrile attack, and very acute pains in almost every part of her body, which were most acute

Fragility of the Bones.

The bones sometimes contain an excess of earthy matter, and are extremely brittle.

To this state they are reduced by old age, and by different diseases, the scurvy, lues, cancer, and more especially in the latter stages of those diseases.

The bones, in the latter stage of scurvy, as Dr MEAD has well remarked, become so brittle, that they break from the slightest violence, and do not consolidate afterwards; for even the callus is destroyed after it has been formed.

Mr BOYER * informs us, that if the bones of a scorbutic person be boiled, the periosteum separates very soon, lamellæ scale off, and in some cases the bones dissolve entirely.

They also fall into powder, if kept for some

in the inferior extremities. After having been in this very distressed situation for nine months, she broke her thigh-bone by turning in bed. The fracture did not heal, though a surgeon applied the broken bones accurately to each other. The bones of the thigh became soft on that side, and then the bones of the other thigh. For the four last years of her life, she suffered very excruciating pain; the softness and flexibility of her bones increased daily. Her breathing became difficult. Spine very crooked; she lost a foot of her height. Spleen was very large, liver very small. All the bones except the teeth were very soft; the periosteum was very thick.

* Vid. his Lectures on the Diseases of bones.

time, but particularly if exposed alternately to heat and moisture.

From the poison of cancer *, the bones are sometimes reduced to so brittle a state as to be broken by the effort of turning in bed, of which a very remarkable case is mentioned in the London Medical Journal.

Louis gives the case of a nun who broke her arm by leaning on a servant as she was entering a carriage.

Anchylosis.

Anchylosis is sometimes the sequel of the various accidents and diseases of the joints, as sprains, dislocations, abscesses, fractures, and white swelling.

The anchylosis is *Imperfect* or *Perfect.*

It was formerly observed, that the synovial apparatus is so disposed, that the more the joint is moved, the greater the quantity of synovia is poured out, and *vice versâ;* and hence, when a joint is kept motionless for some time, the synovia is not secreted in its usual quantity, or this secretion wholly interrupted, in consequence of which, the dry articular cartilages when the joint is moved, rub violently upon each other, and an inflammation follows.

Anchylosis takes place *in two different manners:* the first is by far the most simple form of

* Vid. Plate 7.

the disease, and is not attended by any loss or destruction of substance, and seems to be produced *by means of the inflammation attacking the cartilages*, which is succeeded by the accretion of the bones.

This variety of the disease is also the consequence *of caries of the bones*, the articular cartilages being destroyed, the diseased surfaces of the bones are in immediate contact, and frequently grow together.

In the second species of anchylosis, the bones are united by means of *a shell of bone, which supplies the place of the capsular ligament in the joint.*

General Observations on Fracture.

The bones of the old, which contain a large quantity of earth, are more frequently fractured than those of the young.

Those bones which are *slightly* covered, are more readily broken than the deeper-seated bones.

The bones of persons afflicted by *cancer*, *gout*, *scurvy*, and *scrofula*, are readily broken. LOUIS and SAVIARD have described cases, in which the bones of women afflicted with cancer were broken by so slight an effort as the turning in bed.

Some bones, from their *situation and office*, are much exposed to fracture: thus, the long bones of extremities are often broken, as these serve as pillars or levers.

None of the flat bones are much exposed to fracture, except those of the cranium.

Both tables of the skull are generally fractured.

Fracture is often accompanied by depression of the skull; but in early life, the skull is sometimes depressed, but *not fractured.*

Fractures of the skull generally extend upwards from the place on which the injury was received, but sometimes downwards, and across the base of the skull through the partes petrosæ of the temporal bones, from temple to temple.

Fractures often extend further in the inner than the outer table of the skull, and sometimes follow the course of the principal artery of the dura mater, or, in infants, of the bony fibres.

The *clavicles* and *radii* are much exposed, from their office, to fracture: the former keeps the shoulder and breast-bone at a proper distance, and is more or less affected by every movement of the extremity; the other supports the hand.

The clavicles are not only broken by violence, directly applied, but *by shock communicated:* thus, the clavicle is broken by falls on the shoulder, and also on the hands.

The smaller irregular-shaped bones, as those at the wrist, and in the ancles and feet, may be crushed by a great weight, but can scarcely be said to be broken.

Fractures take place at the *middle, or towards the extremities of the bones.*

Fractures are *simple* or *complicated:* in the former, the injury is limited to the bone and peri-

osteum; in the latter, the muscles and skin are injured. Sometimes bones are broken in several places *.

Fractures are sometimes *incomplete;* and these rarely occur but in the young.

The surfaces of the pieces of the fractured bone touch each other *generally*, as, where another bone serves to support the broken bone; the fibula, for instance, retains pieces of the broken tibia, in immediate contact.

Sometimes *the fractured pieces of bone touch each other only partially;* as, from the foot being turned round when the tibia has been fractured, the outer part of the circumference of the under piece of the broken bone may be applied to the inner part of the circumference of the upper piece.

If the muscles be fixed to both pieces of the broken bone, these are *not disunited;* but if they are only attached to one of these, as in fracture at the neck of the humerus, the teres major and latissimus dorsi draw the under portion upwards and backwards.

If the neck of the thigh-bone be broken, the upper piece having no muscle fixed into it, the muscles fixed to the under and larger piece draw it upwards, so that the limb loses one or two inches of its length.

* Vid. Plate 14.

The muscles fixed into the superior piece of the broken bone, *may bring about a separation of the fractured pieces;* as, when the thigh-bone is broken below the small trochanter, the iliac and psoas muscles draw the upper broken piece upwards and inwards.

When the fractured pieces are not in contact with each other, there is *a luxuriant* growth of callus *, or an imperfect union takes place, and a *new joint is formed.*

In cases of complicated fracture, the neighbouring soft parts are much injured, and sometimes this fracture is combined with a luxation.

General observations on Luxations.

By this term is understood, the displacement of bone from its usual situation.

In different joints, there is a diversity of structure, accommodated to the motion which that joint is capable of performing.

In order to form an accurate opinion respecting the different kinds of luxation, and the method of replacing the dislocated bones, an exact anatomical knowledge, not only of the structure of the joint, but also of the motion it is capable of performing, and of the position of the neighbouring muscles, is required.

* Vid. Plate 13.

Luxations are frequent where a joint admits of free motion, and in different directions. Thus the motions at the shoulder-joints are more free than those of other joints; and hence that joint is more frequently dislocated than any other.

A dislocation is *more rare in the joints like a hinge;* for the extent of surface of the articulation is considerable, and the joint admits of flexion and extension only, and the ligaments are short, thick, and numerous.

The structure of the joints, points out the direction in which *the luxation commonly happens.* Thus the humerus may be dislocated upwards, downwards, inwards or outwards, or the ball of the os humeri may pass over any part of the glenoid cavity.

The direction of the luxation is determined also by the position of neighbouring muscles and tendons; hence, as the capsular ligament at the shoulder, is not so much strengthened at the inner, as at the outer side, luxations inwardly are more frequent than in the contrary direction.

The hip-joint is most commonly dislocated downwards and inwards, from the deficiency of bone at the inner side of the acetabulum.

Luxations are *complete, incomplete,* or *complicated with contusion or fracture.*

In the *complete* luxation, the bone is completely displaced; its articulating surfaces not being in contact.

According to PETIT and others, the capsular ligament is merely stretched; but a complete luxation is generally attended by laceration of ligaments.

My Father, while a student in this University, made many experiments on this subject, and found that he could *not imitate a luxation without a laceration of the ligaments*, even after they had been steeped in tepid water for several hours; and he afterwards, upon dissecting the joints of persons who had died with dislocations, had the satisfaction of finding his former observations confirmed.

There are some joints which can only *be completely luxated*, as the hip-joint, as the smooth head of the thigh-bone is covered by cartilage, and lubricated by synovia, and it either slips from the brim of the acetabulum into its original situation, or into a new situation.

By the *incomplete* dislocation, the head of the bone *is only partially displaced*, and rests upon some part of the socket of the contiguous bone. Such luxations are most frequent at *the elbow*, *knee*, and *foot*.

Luxations may be *complicated* with fracture, contusion, or with a wound of blood-vessels or nerves; hence blood may be effused in the cellular substance, or a degree of palsy produced.

In consequence of the luxation, *the rent in the capsular ligament, through which the head of the bone has passed, fills up; and the torn ligament adheres to the neighbouring parts; the adjacent muscles adapt themselves to the state of the bones, and become stiff; and the head of the displaced bone changes its form.*

If the head of the displaced bone works upon a flat surface, the cellular substance is condensed into a kind of capsular ligament, then osseous matter is deposited around that ligament, so that a new osseous cavity is formed; and hence a person who had been bedridden for years, regains the power of locomotion.

My Father met with a case, where a luxated humerus was lodged in *a new socket*, and tied by new ligaments to the scapula.

Sometimes a *new joint is not formed;* yet the dislocated bones accommodate themselves in such a manner to each other, that the patient can walk for a considerable distance after the disease has been of some duration.

In the last place, the head of the displaced

bone is sometimes retained by new-formed bone in its unnatural situation.

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CHAPTER IX.

GENERAL OBSERVATIONS ON THE ORGANIC DISEASES OF LIGAMENTS.

Ligaments, being serous membranes, are subject to the organic diseases of membranes of a similar structure.

Diseases of the ligaments of the superior extremities are more frequent than those of the inferior.

1st, They are torn in cases of luxation.

2d, They are frequently inflamed, and then become exquisitely sensible, and in consequence of the inflammation, are much thickened, and sometimes suppurate, and the pus works its way outwardly.

3d, By gout and rheumatism, they acquire an unnatural thickness, and are rendered rigid.

4th, Cartilaginous bodies sometimes grow from the ligaments and bursæ mucosæ *.

5th, Tophi are sometimes formed between the layers, or on the outer side of the ligaments.

6th, An unusual relaxation and elongation, sometimes, though rarely, takes place in the capsular ligaments of the joints of the hips or humerus, and hence the head of the humerus, or of the thigh-bone, which generally in such cases shrinks, and is altered in its shape, falls out of its socket.

7th, The ligaments, by scrofula, are reduced to a thickened and spongy state, or to what Dr REIMARUS has properly called *fungus articulorum*. It may be proper to add, that the articular cartilages are softened, and afterwards loosened, by this disease, from the bones, and a quantity of ill-conditioned pus is contained within the joint; and at length the bones are rendered carious.

* Dr MONRO 2d on Bursæ Mucosæ, 1788, p. 82. tab. ix.

8th, Ligaments are sometimes ossified.

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CHAPTER X.

GENERAL OBSERVATIONS ON THE ORGANIC DISEASES OF THE SYNOVIAL APPARATUS.

The Synovial Apparatus is frequently much injured by external violence, so as to become greatly inflamed.

In cases of sprains, bruises, rheumatism and gout, an unnatural quantity of a clear viscid liquor is secreted within the joints, especially within the knee-joint.

The contents of these swellings are various, according to the cause of the disease.

In cases of rheumatism, the contents are thin, and very fluid; in scrofula they are much thicker, and from external violence, blood or cartilaginous bodies are contained within the joint.

On the other hand, it has been stated by GALEN*, that this liquor is secreted in too small quantity, and gives rise to that crackling noise which is observed in the joints of old people.

The synovia, by being pent up, becoming acrid within the joint, has been stated by HILDANUS † to occasion pain, and sinuous ulcers and fistula.

Anchylosis has been said to originate from a defect of the synovia, which is secreted in smaller quantity than usual, in consequence of the limb not being much moved. This is succeeded by an inflammation, and the accretion of the articular cartilages.

CHAPTER XI.

GENERAL OBSERVATIONS ON THE ORGANIC DISEASES OF CARTILAGE.

1. CARTILAGES are rendered thinner by pressure; hence, by long continued pressure on one

* Vid. GALEN, De usu partium, lib. XII. cap. ii. Also BARTHOLIN, Hist. Med. Cent. III. Hist. ii.

† Vid. HILDAN. de Ichore.

side, the body is thrown off its balance, and the foundation of a permanent curvature of the spine is laid.

2. The cartilages are sometimes converted into bone, and united to the body of the bone, especially in persons far advanced in life. The intervertebral cartilages, the cartilages which connect the ribs to the breast-bone, and sometimes also the articular cartilages of the hip and knee joints, have been observed to be ossified.

3. Unnatural pieces of cartilage of a small size, are frequently found within the knee-joint.

4. By scrofula, the cartilages become softer, and are sometimes absorbed; and especially the intervertebral cartilages, and the articular cartilages of the hip and knee joints.

Authors on the Diseases of Cartilages.

Vid. Monro 1's Works, 4to. Bromfield, Ford. Med. Obs. vol. v.

Morgagni, Epist. lvii. art. 14. et Epist. lxix. art. 12.; and Dessault, Journal de Medicine.

CHAPTER XII.

GENERAL OBSERVATIONS ON THE ORGANIC DISEASES OF THE MUSCLES.

The Muscles are frequently inflamed, as, in rheumatism, and this inflammation does not terminate in suppuration, but in debility, rigidity, and the effusion of a gelatinous matter into the sheaths of the tendons, and their bursæ mucosæ.

This inflammation is very apt to change its place, and also to become chronic.

Pus has sometimes been effused between the fasciculi of muscles.

Muscles are sometimes lacerated partially, or wholly, in consequence of violent exertions; as those of the lower extremities, by making a false step, or in dancing.

Sometimes the muscles are extremely tender.

Muscles have been occasionally displaced.

Muscles frequently become paralytic, or are spasmodically contracted.

Some poisons, and especially lead, occasion a remarkable shrinking of the muscles, followed by palsy.

Gangrene may also be enumerated among the organic diseases of muscles.

Muscles have been occasionally converted into a suetty substance *, and also into bone.

Supernumerary Muscles.

Stylopharyngeus alter, Subclavius alter, Curvator coccygis, Interspinales cervicis supernumerarii, Rectus capitis posticus major alter, Rectus capitis lateralis alter, Supinator brevis alter, Extensor proprius digiti medii manûs, Subcrurales, Psoas tertius †.

Muscles awanting.

Many monsters have been born without a heart.

Frequently a portion of the abdominal muscles, or of the diaphragm is awanting ‡.

* Vid. Fœdere, Phys. positive, tom. ii. Richerand, Nosolog. Chirurg.

† Vid. Sandifort, Exercit. Acad. 1. et 2.

‡ Vid. my Observations on Diaphragmatic Hernia, in the Treatise on the Organic Diseases of the Alimentary Canal.

Organic Derangement of Tendons and Tendinous Aponeuroses.

Tendons are frequently lacerated, especially those of the extensor muscles, in consequence of sudden and violent exertions, as in dancing or leaping.

CHAPTER XIII.

GENERAL OBSERVATIONS ON THE ORGANIC DISEASES OF THE BURSÆ MUCOSÆ.

THE organic derangements of the bursæ, which are serous membranes, are similar to those of the ligaments.

Authors on the Diseases of the Bursæ.

MONRO on the Diseases of the Bursæ.
KOCH on the Diseases of the Bursæ.

Explanation of Plate 4th.

This plate is intended to communicate to the reader an idea of the manner in which ossification is carried on in the patellæ of children.

The arteries (called by Mr JOHN HUNTER Labouring) are of large size, and were filled by red blood, and in the act of secreting bone, and which takes place in some children sooner than in others.

Explanation of Plate 5th.

This engraving gives a view of the manner in which the arteries of the muscles anastomose together.

Fig. 1. represents the portion of the muscle, as seen by the naked eye; and fig. 2. represents a magnified view of the same portion of muscle.

Explanation of Plate 6th.

This etching, which has been for thirty years in my father's cabinet, represents rather more than one-half of an exostosis, which grew from one of the metacarpal bones of the fingers; it is very irregular on its surface, and quite different in structure from the bone from which it grew.

ABC represents the metacarpal bone, which was very much bent.

DDDD, the knobby surface of the tumour.

EE point out the bony plates, which pass from one side of the tumour to the other, and in the interstices, there was a gristly matter, and a quantity of ill-conditioned putrid sanies.

F points out one of several large cavities within the exostosis.

GGG points out the thickness of the outer bony shell of the exostosis.

Explanation of Plate 7th.

This plate represents a cancerous tumour of the lower part of the tibia.

Explanation of Plate 8th.

This plate represents the spina ventosa of the lower end of the humerus, of the upper part of the ulna, and of the lower part of the radius.

AA, the lower part of the humerus.
BB, the upper part of the ulna.
C, the upper part of the radius.
D, the lower part of the radius.
EFGH, the bones of the carpus.
KK, &c. the bones of the metacarpus.

Explanation of Plate 9th.

In the several figures of this plate, pieces of different bones, which had been cast off, and their places supplied, are represented.

Fig. 1, 2, 3, 4, 5, 6, and 7, represent portions of the thigh bone which were cast off.

Fig 8, and 9, represent portions of the skull, which were cast off.

Fig. 10, 11, and 12, represent portions of the under jaw, which were cast off in a state of necrosis.

Explanation of Plate 10*th.*

The pieces of the under jaw represented in this plate, were cast off, and their places supplied.

Explanation of Plate 11*th.*

This plate represents a portion of the thigh-bone, which had attained a very unnatural size and thickness.

A, the head of the thigh-bone.

B, the neck of the bone.

C, the trochanter major.

D, the trochanter minor.

E, the body of the thigh-bone.

F, the medullary canal of the bone, which is much less than in the healthy state.

This bone was analysed. Vid. page 38.

Explanation of Plate 12*th.*

This plate represents a portion of the parietal bone, which is of great thickness, in consequence of the extension of the diploe.

The bone was analysed. Vid. page 38.

Explanation of Plate 13*th.*

This plate represents a fracture near to the middle of the clavicle.

Fig. 1. represents the outer surface of the bone.

Fig. 2. represents the inner surface of the sawed bone.

Explanation of Plate 14*th.*

This plate represents a compound fracture of the fore-arm; both bones had been broken, and both have been re-united.

PART II.

CHAPTER I.

OF THE SKELETON.

The skeleton, which differs as to its proportions in different individuals of the same age*, in

* I am deeply indebted to that justly celebrated sculptor Mr JOHN FLAXMAN of London, for the following observations. "The best book I know of proportions is, Les proportions du Corps Humain, by GERARD AUDRAN, which may be also had in English. AUDRAN has measured the *Greek statues*, according to the rules given by VITRUVIUS, from the writings of the best Greek artists, *b. 3. c. 1. de Architectura, Libri Decem.*—The whole passage is highly valuable, because it also furnishes hints concerning the manner in which the ancients applied geometry and numbers to the proportions and motions of the body; this method has also been successfully followed by JOHN ALPHONSO BORELLI, de Motu Animalium, and PROFESSOR CAMPER, in the valuable published fragments of his lectures, all these perfectly agree with the application of geometry and numbers, by PAMPHILUS to painting, according to PLINY, who also mentions the balance of the human figure, in describing the improvements of different artists,

"LEONARDO DA VINCI on painting, disperses in different parts of the book, most excellent observations on the proportions of the body, its balance, and the action of muscles.

different sexes, at the different periods of life, and in different nations, has usually been divided by anatomists into three parts, viz. into the head, trunk and extremities.

The Trunk.

The trunk is subdivided into the Spine, Pelvis and Thorax.

The Spine.

The spine * is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It somewhat resembles two unequal pyramids joined in a common base. It is not, however, straight; for its upper part being drawn backwards by strong muscles, it gradually advances forwards, to support the *œsophagus*, vessels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to support the *viscera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *pelvis*.

The *spine* is commonly divided into *true* and *false vertebræ;* the former constituting the long upper pyramid, which has its base below, while the *false vertebræ* make the shorter lower pyramid, the base of which is above.

"Lomazzo and some other Italian authors, as well as Albert Durer, have written on proportion in a manner too fanciful and indiscriminate to be useful."

* Ῥαχις νωτου ἀκανθα, ἡ ἐφ᾽ ᾗ σύριγξ, σωλην, tergum, hominis carina.

True Vertebræ.

The true vertebræ * are the twenty-four upper bones of the spine, on which the several motions of the trunk of our bodies are performed; from which use they have justly got their name.

Each of these *vertebræ* is composed of its body and processes.

The body is the thick spongy fore-part, which is convex before, concave backwards, horizontal and plain in most of them above and below.

Numerous small holes, especially on the fore and back part of their surface, give passage to their vessels, and allow the ligaments to enter their substance.

The edges of the body of each *vertebra* are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings seem to be joined to the *vertebræ* in the form of *epiphyses*. They are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Intervertebral substance.—Between the bodies of each two adjoining *vertebræ*, a substance *be-*

* Σπονδυλοι, σπόνδυλοι, spondyli, ossa orbiculata, ossa vertebrata, verticula.

tween the nature of ligament and cartilage is interposed; which seems to consist of concentrical curved fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other *.

The outer part of the intervertebral ligaments is the most solid and hard; and they gradually become softer towards the centre. The external fibrous part of each is capable of being greatly extended; and of being compressed into a very small space, while the middle fluid part is incompressible, or nearly so; and the parts of this ligament between the circumference and centre approach in their properties to either, in proportion to their more solid or more fluid texture. The middle point is therefore a *fulcrum* or *pivot*, on which the motion of a ball and socket may be made, with such a gradual yielding of the substance of the ligament, in whatever direction our spines are moved, as saves the body from violent shocks, and their dangerous consequences †.—This ligamento-cartilaginous substance is firmly fixed to the horizontal surfaces of the bodies of the *vertebræ*, to connect them, in which it is as-

* Blancard, Anat. reform. cap. 32.—Weitbreicht. Syndesmolog. sect. 4. § 15.

† Medical essays and observ. vol. 5. art. 28., by Dr Monro *sen.*, Edinburgh.

sisted by a strong membranous ligament, which lines all their concave surface, and by a still stronger ligament that covers all their anterior convex surface.

We may lay it down as a general rule, notwithstanding some exceptions, That the *bodies* of the *vertebræ* are smaller, and more solid above, but as they descend, they appear larger and more spongy; and that the cartilages between them are thick, and the surrounding ligaments strong in proportion to the largeness of the *vertebræ*, and to the quantity of motion they perform: By which disposition, the greater weight is supported on the broadest best secured base, and the middle of our body is allowed a large and secure motion.

Processes.—From each side of the body of each *vertebræ*, a bony bridge is produced backwards, and to a side; from the posterior end of which, one slanting process rises and another descends; the smooth, and what is generally the flattest side of each of these four processes, which are called the *oblique* *, is covered with a smooth cartilage; and the two lower ones of each *vertebra* are fitted to, and articulated with the two upper or ascending oblique processes of the *vertebra* below, having their articular ligaments fixed into the rough line round their edges.

From between the oblique processes of each side

* Articulatorii, minimi.

the *vertebra* is stretched out laterally into a process that is named *transverse*.

From the back-part of the roots of the two oblique, and of the transverse process of each side, a broad oblique bony plate is extended backwards, and where these meet, the seventh process of the *vertebræ* takes its rise, and stands out backwards: This being generally sharp-pointed and narrow-edged, has therefore been called *spinal* process; from which this whole chain of bones has got its name.

Besides the common ligament which lines all the internal surface of the spinal processes, as well as of the bodies, there are particular ligaments that connect the bony bridges and processes of the contiguous *vertebræ* together.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate than the bodies of the *vertebræ* have.

Vertebral Canal.

The seven processes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole, and the holes of all the *vertebræ form a long large conduit**, for containing the *spinal marrow*.—In the upper and lower edge of each *lateral bridge*, there is a notch. These are so adapted to each other in the contiguous *vertebræ*, as to form a round hole in each side between each two *verte-*

* Ἰερὰ συριγξ, σωλήν, Canalis.

bræ, through which the nerves that proceed from the *spinal* marrow and its bloodvessels pass.

Articulations.—The articulations then of these *true vertebræ* are plainly double; for their bodies are joined by the intervening cartilage above described, and their oblique processes being tipped with cartilages, are so connected by their ligaments, as to allow a small degree of motion to all sides. Hence, it is evident, that their centre of motion is altered in different positions of the trunk: For when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebræ*: If we bent back, the oblique processes support the weight: If we recline to one side, we rest upon the oblique processes of that side and part of the bodies: If we stand erect, all the bodies and oblique processes have their share in our support.

Advantages.—Hence it follows, 1. That because the joints of which the spine is composed are so numerous, the *spinal* marrow, nerves, bloodvessels, &c. are not liable to such compression and over-stretching in the motion of the trunk of the body, as they would otherwise be, since several *vertebræ* must be concerned in every motion of the spine; and therefore a very small curvature is made at the conjunction of any two *vertebræ* *. 2. That an erect posture is the surest and firmest, because the surface of contact of the *fulcra* is largest, and the weight is most perpendicular to

* Galen. de usu part. lib. 12. cap. 12.

them *. 3. That the muscles which move the spine, act with greater force in bringing the trunk to an erect posture, than in drawing it to any other: for in bending forwards, backwards, or to a side, the muscles which perform any of these actions are nearer the centre of motion; consequently, the lever with which they act is shorter, than when the centre of motion is on the part of the *vertbra*, opposite to that where these mucles are inserted, which is the case in raising the trunk. This is extremely necessary; since, in the deflections of the spine from a perpendicular bearing, the weight of the body soon inclines it which way we design; whereas, in raising us erect, this great weight must be more than counteracted.

4. In calculating the force exerted by the muscles which move the spine, we should always make allowance for the action of the cartilages between the *vertebræ*, which, in every motion from an erect posture, must be stretched on one side, and compressed on the other, to both which they resist; whereas, in raising the trunk, these cartilages assist by their springy force †.

5. We are hence naturally led into the reason of our height of stature increasing in the morning, and diminishing at night ‡: for the inter-

* Paaw de ossib. part. 2. cap. 2.

† Borelli de motu animal. pars 1. schol. ad propos. 58. Parent Histoire de l'Acad. des Sciences, 1702.

‡ Wasse Philosoph. Transact. numb. 383. art. 1.

mediate cartilages of the *vertebræ* being pressed all day long by the weight of our body, become more compact and thin in the evening; but when they are relieved from this pressure in the night, they again expand themselves to their former thickness; and seeing the bulk of any part must vary according to the different distension or replétion of the vessels composing it, we may understand how we become taller after a plentiful meal, and decrease after fasting or evacuations *.

6. From the different articulations of the bodies, and oblique processes of the *vertebræ*, and the different strength of the ligaments, it is plain, that they are formed so as to allow much larger motion forwards than backwards; this last being of much less use, and might be dangerous, by overstretching the large blood-vessels that are contiguous to the bodies of the *vertebræ* †.

7. The intervertebral cartilages shrivelling as they become more solid by age, is the cause why old people generally bow forwards, and cannot raise their bodies to such an erect posture as they had in their youth.

At the ordinary time of birth, *each vertebra consists of three bony pieces*, connected by cartilages; to wit, the *body*, which is not fully ossified, and a long crooked bone on each side; on which we see a small share of the bony bridge,

* Abbe Fontenu, Histoire de l'Acad. des Sciences, 1725.

† Galen. de usu part. lib. 1. cap. 16.

the oblique processes complete, the beginning transverse processes, and the oblique plate, but no spinal processes, so that the teguments are in no danger of being hurt by the sharp end of these while a child is in its bended posture in the womb, nor while it is squeezed in the birth.

Causes of Deformity of the Spine.

If one or more *vertebræ*, or their cartilages, are of unequal thickness in opposite sides, the spine must be reclined over to the thinner side; which now sustaining the greatest share of the weight, must still be more compressed, consequently hindered from extending itself in proportion to the other side, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The causes on which such *an inequality of thickness in different sides of the vertebræ* depends may vary: for either it may be owing to an overdistension of the vessels of one side, and from thence a preternatural increase of the thickness of that part; or, which more commonly is the case, it may proceed from an obstruction of the vessels, by which the application of proper nourishment to the bony substance is hindered, whether that obstruction depends on the faulty disposition of the vessels or fluids, or whether it is pro-

duced by an unequal mechanical pressure, occasioned by a paralytic weakness of the muscles and ligaments, or by a spasmodic over-action of the muscles on any side of the spine, or by people continuing long, or putting themselves frequently into any posture declining from the erect one: In all these cases one common effect follows, to wit, the vertebræ, or their cartilages, or both, become thicker on that side where the vessels are free, and become thinner on the other side where the vessels are straitened or obstructed.

Whenever any morbid curvature is thus made, *a second turn, but in an opposite direction to the former*, must be formed; both because the muscles on the convex side of the spine being stretched, must have a stronger natural contraction to draw the parts to which their ends are fixed, and because the patient makes efforts to keep the centre of gravity of the body perpendicular to its base, that the muscles may be relieved from a constant violent contractile state, which always creates uneasiness and pain.

The general indication of cure is, to counteract the bending force, by increasing the compression on the convex part of the curvature, and diminishing it on the concave side. The manner of executing which in particular cases must be different, and requires a very accurate examination of the circumstances both of the disease and patient. In many such cases, I have found

some simple directions, as to the posture in which the patient's body should be kept, of very great advantage.

The *true vertebræ* are commonly divided into three classes, viz. *cervical, dorsal,* and *lumbar.*

Cervical Vertebræ.

The *cervical*, the seven uppermost vertebræ,* are distinguished from the rest by these marks: Their bodies are smaller and more solid than any others, and flatted on the fore-part, to make way for the *œsophagus.*

They are also flat behind, where small processes rise, to which the internal ligaments are fixed.

The upper surface of the body of each vertebra is made hollow, by a slanting thin process which is raised on each side: The lower surface is also excavated, but in a different manner; for here the posterior edge is raised a little, and the one before is protruded a considerable way. Hence we see how the cartilages between those bones are firmly connected, and their articulations are secure.

The cartilages between these vertebræ are thick, especially at their fore-part; which is one reason

* Τραχηλος, ἀυχὴν, colli.

why the vertebræ advance forward as they descend, and have larger motion.

The oblique processes of these bones of the neck more justly deserve that name than those of any other vertebræ. They are situated slanting; the upper ones having their smooth and almost flat surfaces facing obliquely backwards and upwards, while the inferior oblique processes have these surfaces facing obliquely forwards and downwards.

The transverse processes of these vertebræ are framed in a different manner from those of any other bones of the spine: For besides the common transverse process rising from between the oblique processes of each side, there is a second that comes out from the side of the body of each vertebra; and these two processes, after leaving a circular hole for the passage of the vertebral artery and vein, unite, and are considerably hollowed at their upper part, with rising sides, to protect the nerves that pass in the hollow; and at last each side terminates in an obtuse point, for the insertion of muscles.

The spinal processes of these cervical bones stand nearly straight backwards, are shorter than those of any other vertebræ, and are forked or double at their ends; and hence allow a more convenient insertion to muscles.

The thick cartilages between the bodies of these *cervical vertebræ*, the obliquity of their *oblique*

processes, and the shortness and horizontal situation of their *spinal* processes, all conspire to allow them large motion.

The holes between the bony cross bridges, for the passage of the nerves from the spinal marrow, have their largest share formed in the lowest of the two vertebræ, to which they are common.

Of the Peculiarities of the Cervical Vertebræ.

First Vertebra or Atlas.

The first, from its use of supporting the head, has the name of *Atlas* * ; and is also called *Epistrophea*,, from the motion it performs on the second.

The *atlas* has no body ; but, instead of it, there is a bony arch : In the convex fore-part of which, a small rising appears, where the *musculi longi colli* are inserted ; and, on each side of this protuberance, a small cavity may be observed, where the *recti interni minores* take their rise.

The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this vertebra to the *os occiptis*, and to the second vertebra are fixed. The back-part of the arch is concave, smooth, and covered with a car-

* Αστραγαλος.

tilage, in a recent subject, to receive the tooth-like process of the second vertebra. In a first vertebra from which the second has been separated, this hollow makes the passage for the sipnal marrow seem much larger than it really is: On each side of it a small rough sinuosity may be remarked, where the ligaments going to the sides of the tooth-like process of the following vertebra are fastened; and on each side, a small rough protuberance and depression is observable, where the transverse ligament, which secures the tooth-like process in the sinuosity, is fixed, and hinders that process from injuring the medulla spinalis in the flexions of the head.

Instead of the spinal process, there is a large bony arch, that the muscles which pass over this vertebra at that place might not be hurt in extending the head.

On the back and upper part of this arch there are two depressions, where the *recti postici minores* take their rise; and at the lower part are two other sinuosities, into which the ligaments which connect this bone to the following one are fixed.

The superior oblique processes of the atlas are large, oblong, hollow, and more horizontal than in any other vertebra. They rise more in their external than internal brim; by which their articulations with the *condyloid* processes of the *os occipitis* are firmer.

Under the external edge of each of these oblique proceses, is the *fossa*, or deep open channel,

in which the vertebral arteries make the circular turn, as they are about to enter the great foramen of the occipital bone, and where the tenth pair of nerves goes out. In several bodies, I have seen this fossa covered with bone. The inferior oblique processes extending from within outwards and downwards, are large, concave, and circular. So that this vertebra, contrary to the other six, receives the bones with which it is articulated both above and below.

The transverse processes are not much hollowed or forked, but are longer and larger than those of any other vertebra of the neck, for the origin and insertion of several muscles; of which those that serve to move this vertebra on the second have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the spinal marrow is larger in this than in any other vertebra, lest the spinal marrow should be hurt by the motions of this vertebra on the second one. This large hole, and the long transverse processes, make this the broadest vertebra of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the superior oblique processes of this vertebra; but the figure of the bones forming these joints, admits of very little motion to either side; and there must be still less circular motion.

In new-born children, the lateral pieces only of this vertebra are ossified; the arch, which it has at its *fore-part instead of a body*, being cartilaginous.

Second Vertebra, or Vertebra Dentata.

The body of this vertebra is somewhat of a pyramidal figure, being large, and produced downwards, especially at its fore-side, to enter into a hollow of the vertebra below; while the upper part has a square process with a small point standing out from it, somewhat resembling a tooth *, and hence the name *vertebra dentata*. The side of this process on which the hollow of the anterior arch of the first vertebra plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind, for the ligament, which is extended transversely from one rough protuberance of the first vertebra to the other, and is cartilaginous in the middle, to move on it.

A ligament likewise goes out in an oblique transverse direction, from each side of the *processus dentatus*, to be fixed at its other end to the first vertebra, and to the occipital bone; and another ligament rises up from near the point of the process to near the os occipitis.

* Gonoides, pyrenoides, odontoides.

The superior oblique processes of this *vertebra dentata* are large, circular, very nearly in an horizontal position, and slightly convex, to be adapted to the inferior oblique processes of the first vertebra.

The inferior oblique processes of this vertebra dentata answer exactly to the description given of those common to all the cervical vertebræ.

The tranverse processes of the vertebra dentata are short, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle substance of each process; so that the course of these vessels may be directed towards the transverse processes of the first vertebra. Had this curvature of the arteries been made in a part so moveable as the neck is, while they were not defended by a bone, and fixed to that bone, scarcely a motion could have been performed without the utmost hazard of compression, and a stop put to the course of the liquids, with all its train of bad consequences. Hence we observe this same mechanism several times made use of, when there is any occasion for a sudden curvature of a large artery, as when the *carotids* pass through the *temporal* bones, or when the vertebral arteries, turning round the oblique processes of the first vertebra, reach the great hole of the occipital bone.

The spinal process of this vertebra is thick, strong, and short, to give sufficient origin to

the *musculi recti majores*, and *obliqui inferiores*, and to prevent the contusion of these and other muscles in pulling the head back.

This second vertebra consists, at the birth, of four bony pieces: For, besides the three which I already mentioned as common to all the vertebræ, the tooth-like process of this bone is begun at this time to be ossified in its middle, and is joined as an appendix to the body of the bone. Lest this appendix be bended or displaced, nurses ought to keep the heads of new-born children from falling too far backwards, by *stay-bands*, or some such means, till the muscles attain strength sufficient to prevent that dangerous motion.

The head is moved forwards and backwards on the first vertebra, while the atlas performs the *circumgyratio* upon the second vertebra; the inferior oblique processes of the first vertebra on the superior oblique processes of the second, and its body or anterior arch revolving on the tooth-like process, by which the perpendicular ligament that is sent from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments that fix the *processus dentatus* to the sides of the first vertebra, and to the *os occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio*, is much shortened and lax, while the opposite one is stretched and made tense, and yielding at last no more, prevents the head from turning any farther round on this axis.

So that these lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here, which must be larger or smaller, as these ligaments are weaker, or stronger, longer, or shorter, and more or less capable of being stretched.

Besides the revolution on this axis, the first vertebra can move a small way to either side; but is prevented from moving backwards and forwards, by its anterior arch, and by the cross ligament, which are both closely applied to the tooth-like process. Motion forwards here would have been of very bad consequence, as it would have brought the beginning of the spinal marrow upon the point of the tooth-like process.

The rotatory motion of the head is of great use to us on many accounts, by allowing us to apply quickly our organs of the senses to objects: and the axis of rotation was altogether proper to be at this place; for if it had been at a greater distance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the small very moveable joint, and thereby had acquired a long lever, would have broken the ligaments at every turn inconsiderately performed; or these ligaments must have been formed much stronger than could have been connected to such small bones.

Nor could this circular motion be performed on the first vertebra without danger, because the immoveable part of the *medulla oblongata* is so near, that at each large turn, the beginning of the

spinal marrow would have been in danger of being twisted, and of suffering by the compression this would have made on its tender fibrils.

It is necessary to observe, that the *lateral* or *moderator* ligaments confine so much the motion of the first vertebra upon the second, that, though this joint may serve us on several occasions, yet we are often obliged to turn our faces farther round, than could be done by this joint alone, without the greatest danger of twisting the spinal marrow too much, and also of luxating the oblique processes; therefore, in large turns of this kind, the rotation is assisted by all the vertebræ of the neck and loins; and if this is not sufficient, we employ most of the joints of the lower extremities. This combination of a great many joints towards the performance of one motion, is also to be observed in several other parts of the body; notwithstanding such motions being generally said to be performed by some single joint only.

The seventh * vertebra of the neck resembles in form those of the back, having the upper and lower surfaces of its body less hollow than the others: The oblique processes are more perpendicular; neither spinal nor transverse processes are forked.

This seventh and the sixth vertebra of the neck have the hole in each of their transverse processes more frequently divided by a small cross

* Atlas quibusdam, maxima, magna vertebra, prominens.

bridge, that goes between the cervical vein and artery, than any of the other vertebræ.

Dorsal Vertebræ.

*The twelve dorsal**, may be distinguished from the other vertebræ of the spine by the following marks.

Their bodies are of a middle size, betwixt those of the neck and loins;—they are more convex before than either of the other two sorts; and are flattened laterally by the pressure of the ribs, which are inserted into small cavities formed in their sides. This flattening on their sides, which makes the figure of these vertebræ almost an half oval, is of good use; as it affords a firm articulation to the ribs, allows the *trachea arteria* to divide at a small angle, and the other large vessels to run secure from the action of the vital organs. These bodies are more concave behind, than any of the other two classes. Their upper and lower surfaces are horizontal.

The cartilages interposed between the bodies of these vertebræ are thinner than in any other of the *true vertebræ;* and contribute to the concavity of the spine in the thorax, by being thinnest at their fore-part.

The *oblique* processes are placed almost perpendicular; the upper ones slanting but a little for-

* Θωρακος, μεταφρένου, νωτου, ὑποτραχήλιου, antisterni, pectoris, tergi.

wards, and the lower ones slanting as much backwards. They have not so much convexity or concavity as is worth remarking.

Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes, strong ligaments are fixed, for connecting the vertebræ.

The *transverse* processes of the *dorsal vertebræ* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the pressure of the ribs, the tubercles of which are inserted into a depression near the end of these processes.

The spinal processes are long, small pointed, and sloping downwards and backwards; from their upper and back part a ridge rises, which is received by a small channel in the fore-part of the spinal process immediately above, which is here connected to it by a ligament.

The *conduit* of the spinal marrow is here more circular, but, corresponding to the size of that cord, is smaller than in any of the other vertebræ, and a larger share of the holes in the bony ridges, for the transmission of the nerves, is formed in the vertebra above, than in the one below.

The connection of the *dorsal vertebræ* to the ribs, the thinness of their cartilages, the erect situation of the oblique processes, the length, sloping, and connection of the spinal processes, all

contribute to restrain these vertebræ from much motion, which might disturb the actions of the heart and lungs; and, in consequence of the little motion allowed here, the *intervertebral* cartilages sooner shrivel, by becoming more solid: And, therefore, the first remarkable curvature of the spine observed, as people advance to old age, is in the least stretched vertebræ of the back; or old people first become round-shouldered.

The bodies of the four uppermost *dorsal vertebræ*, deviate from the rule of the vertebræ becoming larger as they descend; for the first of the four is the largest, and the other three below gradually become smaller, to allow the trachea and large vessels to divide at smaller angles.

The two uppermost vertebræ of the back, instead of being very prominent forwards are flatted by the action of the *musculi longi colli* and *recti majores.*

The proportional size of the two little depressions in the body of each vertebra for receiving the heads of the ribs, seems to vary in the following manner: The depression on the upper edge of each vertebra decreases as far down as the fourth, and after that increases.

The transverse processes are longer in each lower vertebra to the seventh or eighth, with their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards as they descend they become shorter, and the smooth surfaces are directed more upwards.

The spinous processes of the vertebræ of the back become gradually longer and more slanting from the first, as far down as the eighth or ninth vertebra; from which they manifestly turn shorter and more erect.

The first * vertebra, besides an oblong hollow in its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary* †, without any thing particular in its structure.

The eleventh ‡ often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth ‖ always receives the whole head of the last rib, and has no smooth surface on its transverse processes, which are very short.

The smooth surfaces of its inferior oblique processes face outwards as the *lumbar* do. And we may say, in general, that the upper vertebræ of the back lose gradually their resemblance to those of the neck, and the lower ones come nearer to the figure of the lumbar.

The articulation of the vertebræ of the back with the ribs, shall be more particularly considered after the ribs are described. Only it may be

* Ἀορτίαι, gutturalis.

† Μασχαλιαῖος.

‡ Ἀρτιαῖος, in neutram partem inclinans.

‖ Διασωστικός, præcingens.

proper now to remark, that the ligaments which serve that articulation assist in connecting the vertebræ.

Lumbar Vertebræ.

The lowest order of the *true vertebræ* is the *lumbar* *, which are five bones that may be distinguished from many others by these marks:

1. Their bodies, though of a circular form at their fore-part, are somewhat oblong from one side to the other. The *epiphyses* on their edges are larger, and therefore the upper and lower surfaces of their bodies are more concave than in the vertebræ of the back.

2. The cartilages between these vertebræ are much the thickest of any, and render the spine convex towards the abdomen, by their greatest thickness being at their fore-part.

3. The oblique processes are strong and deep; those in opposite sides being placed almost in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of these vertebræ receives the one above it, and is received by the one below; which is not so evident in the other two classes already described.

4. Their transverse processes are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts.

* Οσφὺς' ἰξύος, ψοιῶν, renum, lumborum.

5. Betwixt the roots of the superior oblique and transverse processes, a small protuberance may be observed, where some of the muscles that raise the trunk of the body are inserted.

6. Their spinal processes are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side by muscles. And at the root of these edges, we see rough surfaces for fixing the ligaments.

7. The canal for the numerous cords, called *cauda equina*, into which the spinal marrow divides, is rather larger in these bones than what contains that *marrow* in the vertebræ of the back.

8. The holes for the passage of the nerves are more equally formed out of both the contiguous vertebræ than in the other classes; the upper one furnishes however the larger share of each hole.

The thick cartilages between these *lumbar vertebræ*, their deep oblique processes, and their erect spinal processes, are all fit for allowing large motion; though it is not so great as what is performed in the neck; which appears from comparing the arches which the head describes when moving on the neck, or the loins only.

The *lumbar vertebræ* as they descend, have their oblique processes at a greater distance from each other, and facing more backwards and forwards.

Both transverse and spinal processes of the

middlemost vertebræ of the loins are longest and thickest; in the vertebræ above and below they are less: So that these processes of the first * and fifth † are the least, to prevent their striking on the ribs or ossa ilia, or their bruising the muscles in the motions of the spine.

The *epiphyses* round the edges of the bodies of the *lumbar vertebræ* are most raised in the two lowest, which consequently make them appear hollower in the middle than the others are.

The body of the fifth vertebra is rather thinner than that of the fourth.—The spinal process of this fifth is smaller, and the oblique processes face more backwards and forwards than in any other lumbar vertebræ.

After considering the structure of the particular vertebræ, and their mutual connection, we may observe a solicitous care taken that they shall not be disjoined, but with great difficulty; for besides being connected by strong ligaments proportioned to the forces which are to be resisted, their bodies either enter so into each other, as to prevent their being displaced any way, as in the vertebræ of the neck; or they are propped on all sides, as those of the *back* are by the ribs; or their surfaces of contact are so broad, as to render the separation almost impracticable as in the *loins;* while the depth and articulation of the oblique processes are exactly proportioned to the quantity

* Νεφριτης, renalis.

† Ασχαλίτης, fulciens.

of motion which the other parts of the bones allow, or the muscles can perform : Yet as these oblique processes are small, and therefore not capable of so secure a conjunction as the larger bodies, they may sooner yield to a disjoining force ; but then their dislocation is not of nearly so bad consequence as the separation of the bodies would be. For, by the oblique processes being dislocated, the muscles, ligaments, and spinal marrow are indeed stretched ; but this marrow must be compressed, or entirely destroyed, when the body of the vertebra is removed out of its place.

False Vertebræ.

The *False Vertebræ* compose the under pyramid of the *spine.* They are distinguished from the bones already described justly enough by this epithet of *false ;* because though each bone into which they can be divided in young people resembles the true vertebræ in figure, yet none of them contribute to the motion of the trunk of the body ; they being intimately united to each other in adults, except at their lower part, where they are moveable ; whence they are commonly divided into two bones, *os sacrum*, and *os coccygis.*

All the tranverse processes are united into one large strong oblong process on each side ; which so far as it answers to the first three bones, is very

thick, and divided into two irregular cavities, by a long perpendicular ridge. The foremost of the two cavities has commonly *a thin cartilaginous skin* covering it in the recent subject, and is adapted to the unequal protuberance of the os ilium, and a strong ligament connects the circumference of these surfaces of the two bones. The cavity behind is divided by a transverse ridge into two, where strong ligamentous strings that go from this bone to the os ilium, with a cellular substance containing mucus, are lodged.

The tranverse processes of the two last bones of the os sacrum are much smaller than the former. At their back-part near their edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the os ischium; and are therefore called *sacrosciatic.*

The spinal processes of the three uppermost bones of the os sacrum appear short, sharp, and almost erect, while the two lower ones are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen; and sometimes none of them meet, but leave a sinus, or rather fossa, instead of a canal *. The musculus latissimus and longissimus dorsi, sacro-lumbalis, and glutæus maximus, have part of their origins from these spinal processes.

* Verheyen, Anat. trac. 5. cap. 9.—Sue Trad. d'osteol. p. 127.

Canal.—The *canal* between the bodies and processes of this bone, for the cauda equina, is triangular; and becomes smaller as it descends, as the cauda also does. Below the third bone, this passage is no more a complete bony canal, but is open behind; and is there defended only by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

Foramina.—At the root of each oblique process of this bone, the notch is conspicuous, by which, and such another in the last vertebra of the loins, a passage is left for the *twenty-fourth spinal nerve;* and, in viewing the os sacrum, either before or behind, four large holes appear in each side, in much the same height, as where the marks of the union of its several bones remain. Some of the *largest nerves of the body* pass through the anterior holes; and superficial grooves running outwards from them in different directions, shew the course of these nerves.

From the intervals of these grooves, the pyriformis muscle chiefly rises. The holes in the back-part of the bone are covered by membranes which allow small nerves to pass through them.

The two uppermost of these holes, especially on the fore-side, are the largest; and as the bone descends, the holes turn smaller. Sometimes a notch

* Verheyen, Anat. tract. 5. cap. 9. Sue Trad. d'osteol. p. 137.

only is formed at the lower part in each side of this bone; and in other subjects there is a hole common to it and the os coccygis, through which the twenty-ninth pair of spinal nerves passes; and frequently a bony bridge is formed on the back-part of each side by a process sent up from the back-part of the os coccygis, and joined to the little knobs which the last bone of the os sacrum has instead of a spinal process. Under this bridge or jugum, the twenty-ninth pair of spinal nerves runs in its course to the common holes just now described.

The upper part of the body of the first bone resembles the vertebræ *of the loins*; but the small fifth bone is oblong transversely, and hollow in the middle of its lower surface.

The substance of the os sacrum is very spongy, without any considerable solid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is secured from injuries by the thick muscles that cover it behind, and by the strong ligamentous membranes. As this is one of the most remarkable instances of this sort of defence afforded a soft weak bone, we may make the general observation, that wherever we meet with such a bone, one or other, or both these defences are made use of; the first to ward of injuries, and the second to keep the substance of the bone from yielding too easily.

This bone is articulated above to the last vertebra *of the loins*, in the manner that the lumbar ver-

tebræ are joined; and therefore the same motions may be performed here.

The articulation of the lower part of the os sacrum to the os coccygis seems well enough adapted for allowing considerable motion to this last bone, was it not much confined by ligaments. Laterally, the os sacrum is joined to the ossa ilia by an *immoveable* synchondrosis, or what almost deserves the name of a suture; for the cartilaginous crust on the surface of the bones is very thin, and both their surfaces are so scabrous and unequal, as to be indented into each other; which makes such a strong connexion, that great force is required to separate them, after all the muscles and ligaments are cut. Frequently the two bones grow together in old subjects.

The os sacrum *serves as the common base and support of the trunk of the body, to guard the nerves proceeding from the end of the spinal marrow, to defend the back part of the pelvis, and to afford sufficient origin to the muscles which move the trunk and thigh* *.

State at Birth.—The bones that compose the os sacrum of infants, are separated from each other by a thick cartilage; and, in the same manner as the true vertebræ, each of them consists of a body and two lateral plates, connected together by cartilages; the ends of the plates seldom being contiguous behind.

* Vid. a very excellent Dissertation on this Bone by ALBINUS, in his An. Acad.

Os Coccygis.—Os Coccygis *, or rump-bone, is that triangular chain of bones depending from the os sacrum; each bone becoming smaller as they descend, till the last ends almost in a point.

The os coccygis is convex behind, and concave before; from which crooked pyramidal figure, which was thought to resemble a cuckow's beak, it has got its name.

This bone consists of four pieces in people of middle age: In children, very near the whole of it is cartilage: In old subjects, all the bones are united, and become frequently one continued bone with the os sacrum.

The highest of the four bones *is the largest*, with shoulders extended farther to each side than the end of the os sacrum; which enlargement should, in my opinion, serve as a distinguishing mark to fix the limits of either bone. The upper surface of this bone is a little hollow. From the back of that bulbous part called its *shoulders*, a process often rises up on each side, to join with the bifurcated spine of the fourth and fifth bones of the os sacrum, to form the bony bridge mentioned in the description of the os sacrum. Sometimes these shoulders are joined to the sides of the fifth bone of the os sacrum, to form the hole in each side common to these two bones, for the passage of the twenty-ninth pair of spinal nerves.

* Οξξοπυγιον, οξξος, caudæ os, spondylium, os cuculi.

Immediately below the shoulders of the os coccygis, a notch may be remarked in each side, where the thirtieth pair of the spinal nerves passes. The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually *become smaller, and are spongy ;* but are strengthened by a strong ligament which covers and connects them. Their ends, by which they are articulated, are formed in the same manner as those of the first bone are.

Between each of these four bones of young subjects, a cartilage is interposed ; like the bodies of the vertebræ of the neck : For, as has been above remarked, the lower end of the os sacrum, and of each of the three superior bones of the os coccygis, has a small depression in the middle ; and the upper part of all the bones of the os coccygis is a little concave, and consequently, the interposed cartilages are thickest in the middle, to fill up both cavities ; by which they connect the bones more firmly. When the cartilages ossify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.

From this sort of articulation, it is evident, that, unless when these bones grow together, all of them are capable of motion ; of which, the first and second, especially this last, enjoys the largest share.

The lower end of the fourth bone terminates

in a rough point, to which a cartilage is appended.

To the sides of these bones of the os coccygis, the coccygæi muscles *, and part of the levatores ani, and of the glutæi maximi, are fixed.

The substance of these bones is very spongy, and in children cartilaginous; there being only a part of the first bone ossified in a new-born infant. Since, therefore, the intestinum rectum of children is not so firmly supported as it is in adults, this may be one reason *why they are more subject to a procidentia ani* than old people †.

This bone cannot be moved to either side; and its motion backwards and forwards is much confined: Yet, as its ligaments can be stretched by a considerable force, it is a great advantage in the excretion of the fæces alvinæ, and much more in child-bearing, that this bone should remain moveable; and the right management of it, in delivering women, may be of great benefit to them ‡.

The mobility of the os coccygis diminishing as people advance in age, especially when its ligaments and cartilages have not been kept flexible by being stretched, is probably one reason why

* Douglas, Myograph. chap. 40.—Eustach. tab. 36. No. 45. 20.

† Spigel. de humani corp. fabric. lib. 2. cap. 22.—Paaw, de ossib. par. 2. cap. 3.

‡ Paaw, ibid.—Deventer, Operat. chirurg. cap. 27.

the women, who are old maids before they marry, have generally hard labour in child-bed.

The os coccygis *serves to sustain* the intestinum rectum; and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which also the bone itself, as well as the muscles and teguments, is preserved from any injury, when we sit with our body reclined back.

Ossa Innominata.

The OSSA INNOMINATA are two large broad bones, which form the fore-part and sides of the pelvis, and the lower part of the sides of the abdomen.

In children each of these bones is evidently divided into three; which are afterwards so intimately united, that scarcely the least mark of their former separation remains: Notwithstanding this, they are described as consisting each of three bones, to wit, the os ilium, ischium, and pubis.

Os Ilium.

THE *Os Ilium* *, or haunch-bone, is situated highest of the three, and reaches as far down as

* Ἀγχόνων, κενεῶν, scaphium, lumbare, clunium, clavium, anchas.

one third of the great cavity into which the head of the thigh-bone is received.

The external side of this bone is unequally convex, and is called its dorsum;—the internal concave surface is by some (but improperly) named its costa.

The semicircular edge at the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the spine, into which the external or descending oblique muscle of the abdomen is inserted; and from it the internal ascending oblique and the transverse muscles of the belly, with the glutæus maximus, quadratus lumborum, and latissimus dorsi, have their origin. Some* are of opinion, that it is only the tendinous crust of all these muscles, and not a cartilage, as commonly alleged, that covers this bony edge.

The ends of the spine are more prominent than the surface of the bone below them; therefore are reckoned processes.

From the anterior spinal process, the sartorius and fascialis† muscles have their rise, and the outer end of the doubled tendon of the external oblique muscle of the abdomen, commonly called Fallopius's or Poupart's ligament, or Crural arch, is fixed to it.—The inside of the posterior spinal process, and of part of the spine forward from

* Winslow, Exposition anatomique du corps humain, traité des os frais, § 96.

† Tensor vaginæ femoris. Alb.

that, is made flat and rough where the sacrolumbalis and longissimus dorsi rise; and to its outside are fixed ligaments, extended to the os sacrum and transverse processes of the fifth and fourth vertebræ of the loins *.

Below the anterior spinal process another protuberance stands out, which, by its situation, may be distinguished from the former, by adding the epithet of *inferior*, where the musculus rectus tibiæ † has its origin ‡.

Besides these two anterior processes the bone is hollowed where the beginning of the sartorius muscle is lodged. Below the posterior spinal process, a second protuberance of the edge of this bone is in like manner observable, which is closely applied to the os sacrum. Under this last process a considerable large niche is observable in the os ilium; between the sides of which and the strong ligament that is stretched over from the os sacrum to the sharp-pointed process of the os ischium of the recent subject, a large hole is formed, through which the musculus pyriformis, the great sciatic nerve, and the posterior crural vessels pass, and are protected from compression.

The external broad side or dorsum of the os ilium is a little hollow towards the fore-part; farther back it is as much raised; then is considerably concave, and lastly, it is convex. These in-

* Weitbrecht, Syndesmolg. sect. 4. § 39, 40, 46, 47.

† Rectus cruris Alb.

‡ Baker, Curs. osteolog. demonstr. 3.

equalities are occasioned by the actions of the muscles that are situated on this surface.

From behind the uppermost of the two anterior spinal processes, in such bones as are strongly marked by the muscles, a semicircular ridge is extended to the hollow passage of the sciatic nerve. Between the spine and this ridge, the glutæus medius takes its rise. Immediately from above the lowest of the anterior spinal processes, a second ridge is stretched to the niche. Between this and the former ridge, the glutæus minimus has its origin. On the outside of the posterior spinal processes, the dorsum of the os ilium is flat and rough, where part of the musculus glutæus maximus and pyriformis rises. The lowest part of this bone is the thickest, and is formed into a large cavity with high brims, to assist in composing the great acetabulum; which shall be considered, after all the three bones that constitute the os innominatum are described.

The internal surface of the os ilium is concave in its broadest fore-part, where the internal iliac muscle has its origin, and some share of the intestinum ilium and colon is lodged.

From this large hollow, a small sinuosity is continued obliquely forwards, at the inside of the anterior inferior spinal process, where part of the psoas and iliacus muscles, with the crural vessels and nerves pass. The large concavity is bounded below by a sharp ridge, which runs from behind forwards; and, being continued with such ano-

ther ridge of the os pubis, forms a line of partition between the abdomen and pelvis. Into this ridge the broad tendon of the psoas parvus is inserted.

The internal surface of the os ilium, behind this ridge, is very unequal: For the upper part is flat, but spongy, where the sacrolumbalis and longissimus dorsi rise.

Lower down, there is a transverse ridge from which ligaments go out to the os sacrum. Immediately below this ridge, the rough unequal cavities and prominences are placed, which are exactly adapted to those described on the side of the os sacrum.

In the same manner, the upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid, and covered with a thin cartilaginous skin, for its immoveable articulation with the os sacrum. From the circumference of this large unequal surface, ligaments are extended to the os sacrum, to secure more firmly the conjunction of these bones.

The passages of the medullary vessels are very conspicuous, both in the dorsum and costa of many ossa ilia; but in others they are inconsiderable.

The posterior and lower parts of these bones are thick; but they are generally exceedingly thin and compact at their middle, where they are exposed to the actions of the musculi glutæi

and iliacus internus, and to the pressure of the bowels contained in the belly.

The substance of the ossa iliais mostly cellular, except a thin external table.

In a ripe child, the spine of the os ilium is cartilaginous, and is afterwards joined to the bone in form of an epiphysis *. The large lower end of this bone is not completely ossified.

Os Ischium.

Os ISCHIUM †, or hip-bone, *is of a middle bulk between the two other parts of* the os innominatum; is situated lowest of the three, and is of a very irregular figure.

Its extent might be marked by an horizontal line drawn nearly through the middle of the acetabulum; for the upper bulbous part of this bone forms somewhat less than the lower half of that great cavity, and the small leg of it rises to much the same height on the other side of the great hole common to this bone and the os pubis.

Processes.—From the upper part of the os ischium, a sharp process, called by some spinous, stands out backwards, from which chiefly the musculus coccygæus and superior gemellus, and part of the levator ani, rise; and the interior or internal sacrosciatic ligament is fixed to it.

* Vid. ALBINUS's tables of the bones of the fœtus.

† Coxæ, coxendicis, pixis.

Between the upper part of this ligament and the bones, it was formerly observed that the pyriform muscle, the posterior crural vessels, and the sciatic nerve, pass out of the pelvis. Immediately below this process, a sinuosity is formed for the tendon of the musculus obturator internus. In a recent subject, this part of the bone, which serves as a pully on which the obturator muscle plays, is covered with a ligamentous cartilage, that, by two or three small ridges, points out the interstices of the fibres in the tendon of this muscle. The outer surface of the bone at the root of this spinous process is made hollow by the pyriformis or iliacus externus muscle.

Below the sinuosity for the obturator muscle, is the great knob or tuberosity, covered with cartilage or tendon *. The upper part of the tuberosity gives rise to the inferior gemellus muscle. To a ridge at the inside of this, the external or posterior sacrosciatic ligament is so fixed, that between it, the internal ligament, and the sinuosity of the os ischium, a passage is left for the internal obturator muscle. The upper thick smooth part of the tuber, called by some its dorsum, has two oblique impressions on it. The inner one gives origin to the long head of the biceps flexor cruris and semitendinosus muscles, and the semimembranosus rises from the exterior one, which reaches higher and nearer the acetabulum than the other.

* Winslow, Exposit. Anat. des os frais, § 96.

The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat surfaces, whereof the internal is what we lean upon in sitting, and the external gives rise to the largest head of the triceps adductor femoris *.

Between the external margin of the tuberosity and the great hole of the os innominatum, there is an obtuse ridge extended down from the acetabulum, which give sorigin to the quadratus femoris. As the tuber advances forwards, it becomes smaller, and is rough, for the origin of the musculus transversalis † and erector penis.

The small leg of it, which mounts upwards to join the os pubis, is rough and prominent at its edge, where the two lower heads of the triceps or quadriceps adductor femoris ‡ take their rise.

The upper and back part of the os ischium is broad and thick; but its lower and fore-part is narrower and thinner. Its substance is of the structure common to broad bones.

The os ilium and pubis of the same side, are the only bones which are contiguous to the os ischium.

* Adductor magnus femoris Alb.

† Transversus perinæi Alb.

‡ Adductor longus and A. brevis femoris Alb.

The part of the os ischium which forms the acetabulum, the spinous process, the great tuber, and the recurved leg, are all cartilaginous at birth. The tuber, with part of the leg or process above it, becomes an epiphyse before this bone is fully formed.

Os Pubis.

The Os PUBIS *, or share bone, *is the least* of the three parts of the os innominatum, and is placed at the upper fore-part of it.

The thick largest part of this bone is employed in forming the acetabulum; from which becoming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the os ischium.

The upper fore-part of each os pubis is tuberous and rough where the musculus rectus and pyramidalis are inserted. From this a ridge is extended along the upper edge of the bone, in a continued line with such another of the os ilium, which divides the abdomen and pelvis.

The ligament of FALLOPIUS, or *crural arch*, is fixed to the internal end of this ridge, and the smooth hollow below it is made by the psoas and iliacus in-

* Ηβης, pectinis, penis pudibundum, fenestratum.

ternus muscles passing with the anterior crural vessels and nerves behind the ligament. Some way below the former ridge, another is extended from the tuberous part of the os pubis downwards and outwards towards the acetabulum; between these two ridges the bone is hollow and smooth, for lodging the head of the pectineus muscle.

Immediately below, where the lower ridge is to take the turn downwards, a winding niche is made, which is comprehended in the great foramen of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery, and a vein.

The internal end of the os pubis is rough and unequal, for the firmer adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side: The process which goes down from that to the os ischium is broad and rough before, where the gravilis and upper heads of the triceps, or rather quadriceps adductor femoris have their origin.

The substance of the os pubis is the same as of other broad bones.

State at Birth.—Only a part of the large end of this bone is ossified, and the whole leg is cartilaginous, in a child born at the full time.

Thyroid hole.—Betwixt the os ischium and pubis, a very large irregular hole is left, which, from its resemblance to a door or shield, has been cal-

led *thyroides*. This hole is all, except the niche for the posterior crural nerve, filled up in a recent subject with a strong ligamentous membrane, that adheres very firmly to its circumference. From this membrane chiefly the two obturator muscles, external and internal, take their rise.

The great design of this hole, besides rendering the bone lighter, is to allow a strong enough origin to the obturator muscles, and sufficient space for lodging their bellies, that there may be no danger of disturbing the functions of the contained viscera of the pelvis, by the actions of the internal, nor of the external being bruised by the thigh bone, especially by its lesser trochanter, in the motions of the thigh inwards: Both which inconveniences must have happened, had the ossa innominata been complete here, and of sufficient thickness and strength to serve as the fixed point of these muscles.

The bowels sometimes make their way through the niche for the vessels, at the upper part of this thyroid hole, and this causes a hernia in this place *.

In the external surface of the ossa innominata, near the outside of the great hole, a large deep cavity is formed by all the three bones conjunctly: For the os pubis constitutes about one-fifth; the

* Memoires de l'Acad de Chirurgie, tom. 1. p. 709. &c.

os ilium makes something less than two-fifths, and the os ischium as much more than two-fifths.

The brims of this cavity are very high, and are still much more enlarged by the ligamentous cartilage, with which they are tipped in a recent subject. From this form of the cavity it has been called *acetabulum;* and for a distinguishing character, the name of the bone that constitutes the largest share of it is added; therefore acetabulum ossis ischii *, is the name this cavity commonly bears. Round the base of the supercilia, the bone is rough and unequal, where the capsular ligament of the articulation is fixed. The brims at the upper and back-part of the acetabulum, are much larger and higher than any where else; which is very necessary to prevent the head of the femur from slipping out of its cavity at this place, where the whole weight of the body bears upon it, and consequently would otherwise be constantly in danger of thrusting it out.

As these brims are extended downwards and forwards, they become less; and at their internal lower part a breach is made in them; from the one side of which to the other, *a ligament* is placed in the recent subject; under which a large hole is left, which contains fat, cellular substance and vessels. The reason of which appearance has afforded matter of debate. To me it seems evidently contrived for allowing a larger motion to

* Coxæ, coxendicis.

the thigh inwards: For if the bony brims had been here continued, the neck of the thigh-bone must have struck upon them when the thighs were brought across each other; which, in a large strong motion this way, would have endangered the neck of the one bone, or brim of the other.

Then the vessels which are distributed to the joint may safely enter at the sinuosity in the bottom of the breach; which being however larger than is necessary for that purpose, allows the synovial apparatus of the joint to escape below the ligament, when the head of the thigh-bone is in hazard of pressing too much upon it in the motions of the thigh outwards *. Besides this difference in the height of the brims, the acetabulum is otherwise unequal: For the lower internal part of it is depressed below the cartilaginous surface of the upper part, and is not covered with cartilage; into the upper part of this particular depression, where it is deepest and of a semilunar form, the ligament of the thigh-bone, commonly, though improperly, called the round one, is inserted; while in its more superficial lower part the large mucilaginous gland of this joint is lodged. The largest share of this separate depression is formed in the os ischium.

From what has been said of the condition of the three bones composing this acetabulum in new-

* Petit, Memoires de l'Acad, des Sciences, 1722.

born children, it must be evident, that a considerable part of this cavity is cartilaginous in them.

Of the connexion of the Ossa Innominata and Sacrum.

The *ossa innominata* are joined at their back part to each side of the *os sacrum* by a sort of suture, with *a very thin intervening cartilage*, which serves as so much glue to cement these bones together; and strong ligaments go from the circumference of this unequal surface, to connect them more firmly This joining has been called posterior symphysis, in contradistinction to the anterior symphysis. The ossa innominata are connected together at their fore-part by the ligamentous cartilage interposed between the two ossa pubis.

These bones can therefore have no motion in a natural state, except what is common to the trunk of the body, or to the os sacrum. It has been disputed, whether or not they loosen so much from each other, and from the os sacrum, in child-birth, by the throws of the labour, as that the ossa pubis recede from each other, and thereby allow the passage between the bones to be enlarged. Several observations * shew that this relaxation sometimes

* Bauhin. Theat. anat. lib. 1. cap. 49.—Spigel. anat. lib. 2. cap. 24.—Riolan. Anthropogr. lib. 6. cap. 12.—Diemerbroeck, anat. lib. 9. cap. 16.

happens: Those who had frequently opportunities of dissecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; as they found relaxation in very few of the bodies which they examined *.

Considering what great weight is supported in our erect posture, by the articulation of the ossa innominata with the os sacrum, there is great reason to think that if the conglutinated surfaces of these bones were once separated, (without which, the ossa pubis cannot shuffle on each other,) the ligaments would be violently stretched, if not torn; from whence many disorders would arise †.

Each os innominatum *affords a socket* (the acetabulum) *for the thigh-bones to move in, and the trunk of the body rolls here so much on the heads of the thigh-bones, as to allow the most conspicuous motions of the trunk, which are commonly* thought to be performed *by the bones of the spine.*

Before concluding this branch of the subject, it may be not improper to add, that the pelvis varies very much as to its size, and the proportion of its parts in the different sexes, in different women, in the inhabitants of different nations, and also at different periods of life. In the most celebrated sta-

* Hildan. Epist. cent. obs. 46. Dionis Sixieme demonst. des os. Morgagn. Advers. 3. animad. 15.

† Ludov. in Ephem. German. dec. 1. ann. 3. obs. 255.

tues of antiquity, Dr CAMPER informs us, he had remarked the following proportions:

In the *Farnese Hercules*, the breadth, compared with the depth, is as 12 to $8\frac{1}{2}$.

In the *Pythian Apollo*, it is as 9 to 7.

In the *Antinous*, it is as $11\frac{1}{2}$ to $8\frac{1}{2}$.

And in the *Venus de Medicis*, as 11 to $8\frac{1}{2}$.

The pelvis is different as to the proportions of its parts in different women.

The pelvis has been divided into three parts, viz. the brim or introitus, the cavitas, and the inferior aperture or exitus. In the standard pelvis, a line drawn from the sacrum to the os pubis, measures rather more than 4 inches, from one os ilium to the other, 5 inches and $\frac{1}{4}$; and in the lower part or inferior aperture of the pelvis, these proportions are reversed; for a line from the symphysis pubis, to the os coccygis, allowing an inch for the retraction of that bone, is equal to 5 inches.

In the standard pelvis, the pelvis is about $3\frac{1}{2}$ inches at the sides, 6 inches behind, and about $1\frac{1}{2}$ inch before.

When a pelvis exceeds the above dimensions, it has been called too large, and when less, it is said to be too small.

The pelvis may be symmetrical, and at the same time too small, owing to its component bones not being sufficiently expanded, or it may be too small in consequence of a general or partial distortion of its bones, the effect of mollities ossium,

or rickets, from exostoses growing inwardly, or from diseases of the viscera of the pelvis.

The pelvis is differently formed in different nations, as is evident from the subjoined plate, which was taken from a drawing of the justly celebrated Dr PETER CAMPER.

Explanation of Plate 15th, given by Dr Camper.

Linea continua, designat . . . . . Europæam.
—— punctata, ... Asiaticam.
—— lineolis longis, ... Claudam.
—— lineolis, punctis interspersis, . Æthiopissam.

A, B, C, D, E, F, ossa pubis Europææ, cujus pelvis est ampla optime composita; AB, altitudo os. pubis, C, A, D, angulus ossium pubis = 100 seu 50 + 50 = CAJ + JAD, GAH rotunditas ossium pubis sub symphisi.

A, b, c, d, e, f, Asiaticæ.

A, b, altitudo oss. pubis, c. g. A. h. d. amplitudo oss. pubis.

g. A. h. rotunditas oss. pub. sub. Symph. angulus, c. g. A. h. d. z 110. bis 55.

A, b, Γ, d, E, f, Claudæ Europææ. Altitudo oss. pub. ut in Asiatica.

J. A. λ. coincidit cum illo Europææ. z 50. d. ischium vero brevius.

J. A. g. Γ. angulus lateris claudi, dextri, major, z 63. grad. os ischium brevius sinistro.

C. Δ. A. Θ. D. Æthiopissæ,—coinciderit hæc pelvis penitus cum Europææ pelvi, nisi ex Δ. per A. ad Θ. magis esset excavata, adeo ut fere respondeat Asiaticæ.

Altitudo A, B. eadem ac in Europæa.

P. CAMPER *mensuravit*, 24 Junii 1785.

The form of the cavity of the pelvis of the infant, is widely different from that of the adult.

The pelvis is not completely formed until the period of puberty.

In very early life, the pelvis somewhat resembles a cone, of which the coccyx and tuberosities of the ischia form the apex, and the ilium the base, or the proportions of the pelvis are precisely opposite to those of the pelvis of the adult.

Upon the various causes of deformity of the pelvis, the reader may consult SANDIFORT's Mus. Lugd. Batav. SMELLIE's Midwifery. Dr HULL's Tables. Edin. Med. Phys. Jour. vol. vi.

Of the Thorax.

The *thorax**, or *chest*, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity: the figure of which is somewhat conchoidal†, but its upper smaller end is not finished, being left open for the passage of the windpipe, gullet, and large bloodvessels; and its lower part,

* Pectus, cassum.

† The figure of the thorax is very various; in some it is large and elevated, but in others flat and contracted: and frequently in consequence of improper compression. Stays tightly laced deform the chest, and by interrupting the functions of the contained viscera, often lay the foundation of bad health.

or base, has no bones, and is shorter before than behind; so that, to carry on our comparison, it appears like an oblique section of the conchoid. The lower part of this cavity is narrower than some way above *; and the middle of its back-part is considerably diminished by the bones standing forwards into it.

The bones which form the thorax are the *twelve dorsal vertebræ* behind, *the ribs* on the sides, and *the sternum* before.

The *ribs*, or *costæ* †, (as if they were custodes, or guards, to these principal organs of the animal machine, the heart and lungs), are the long crooked bones placed at the side of the chest, in an oblique direction downwards in respect of the back-bone. Their number is generally twelve on each side; though frequently eleven or thirteen have been found ‡. Sometimes the ribs are found preternaturally conjoined or divided §.

The ribs are concave internally; where they are also made smooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and are convex externally, that they might resist that part of the pressure of the atmosphere, which is not balan-

* Albin. de Ossib. § 169.

† Πλευραί, περιοίκεναι, σπάθαι.

‡ Riolan Comment. de Ossib. cap. 19. Marchetti, cap. 9. Cowper Explicat. tab. 93. and 94. Morgagn. Advers. anat.

‡ Sue Trad. d'Osteolog. 141.

ced by the air within the lungs, during inspiration.

The ends of the ribs next the vertebræ are rounder than they are after these bones have advanced forwards, when they become flatter and broader, and have an upper and lower edge, each of which is made rough by the action of the intercostal muscles, inserted into them. Which muscles, being of nearly equal force, and equally stretched in the interstices of the ribs, prevent the broken ends of these bones in a fracture from being removed far out of their natural place, to interrupt the motion of the vital organs.

The upper edge of the ribs is more obtuse and rounder than the lower, which is depressed on its internal side by a long fossa, for lodging the intercostal vessels and nerves; on each side of which there is a ridge, to which the intercostal muscles are fixed. The fossa is not observable, however, at either end of the ribs; for at the posterior or root, the vessels have not yet reached the ribs; and, at the fore-end, they are split away into branches: hence the greater safety of performing the operation of the empyema towards the sides of the thorax, than either near the back or the breast.

At the posterior end of each rib, a little head is formed, which is divided by a middle ridge into two plane or hollow surfaces; the lowest of which is the broadest and deepest in most of them. The

two planes are joined to the bodies of two different vertebræ, and the ridge forces itself into the intervening cartilage. A little way from this head, we find, on the external surface, a small cavity, where glands are lodged; and round the head, the bone appears spongy, where the capsular ligament of the articulation is fixed. Immediately beyond this a flatted tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two vertebræ, with the bodies of which the head of the rib is joined. Advancing further on this external surface, we observe in most of the ribs another smaller tubercle, into which ligaments which connect the ribs to each other, and to the transverse processes of the vertebræ and portions of the longissimus dorsi, are inserted. Beyond this the ribs are made flat by the sacro-lumbalis muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its *angle*. Then the rib begins to turn broad, and continues so to its anterior end *, which is hollow and spongy, for the reception of, and firm coalition with the cartilage that runs thence to be inserted into the sternum, or to be joined with some other cartilage.

In adults generally the cavity at this end of the ribs is smooth and polished on its surface; by

* Πλάτη, Palmula.

which the articulation of the cartilage with it has the appearance of being designed for motion; but it has none.

The substance of the ribs is spongy, cellular, and only covered with a very thin external lamellated surface, in which the fibres are more distinct than in most other bones, and which increases in thickness and strength, as it approaches the vertebræ. In the *rickets, these spongy anterior ends of the ribs swell;* hence the sternum appears to be more depressed than it really is.

To the fore-end of each rib, a long broad and strong cartilage is fixed, and reaches thence to the sternum, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for generally the cartilages make a considerable curve, the concave part of which is upwards; therefore, at their insertion into the sternum, they make an obtuse angle above, and an acute one below.

These cartilages are of such a length, as never to allow the ribs to come to a right angle with the spine; but keep them situated so obliquely, as to make an angle very considerably obtuse above, till a force exceeding the elasticity of the cartilages is applied. These cartilages, as all others, are firmer and harder internally, than they are on their external surface; and sometimes, in old people, their middle substance becomes bony, while a thin cartilaginous lamella appears externally *. The ossi-

* Vesal. lib. 1. cap. 19.

fication however begins frequently at the external surface. The greatest alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous, after all the rest is ossified *.

The ribs are articulated at each end, of which the one behind is doubly joined to the vertebræ; for the head is received into the cavities of two bodies of the vertebræ, and the larger tubercle is received into the depression in the transverse process of the lower vertebra. This double articulation, admits of motion upwards and downwards only, since the transverse process hinders the rib to be thrust back; the resistance on the other side of the sternum, prevents the rib's coming forward; and each of the two joints with the other parts attached, oppose its turning round. It is likewise evident, that even the motion upwards and downwards can be but small in any one rib at the articulation itself. But as the ribs advance forwards, the distance from their centre of motion increasing, the motion must be more extensive; and it would be very conspicuous at their anterior ends, were not they resisted there by the cartilages, which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist remarkable in the long ribs at the place near their fore-end where they are most resisted †.

* Havers, Osteolog. nov. Disc. 5. p. 289.

† Winslow, Memoires de l'Acad. des Sciences, 1720.

Of the peculiarities of the Ribs.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any. Their obliquity in respect of the spine increases as they descend; so that though their distances from each other is very little different at their back-part, yet at their fore-ends the distances between the lower ones must increase. In consequence of this increased obliquity of the lower ribs, each of their cartilages makes a greater curve in its progress from the rib towards the sternum; and the tubercles, that are articulated to the transverse processes of the vertebræ, have their smooth surfaces gradually facing more upwards. From the ribs becoming thus more oblique, while the sternum advances forwards in its descent, the distance between the sternum and the anterior end of the lower ribs is greater than between the sternum and the ribs above; consequently the cartilages of those ribs that are joined to the breast-bone are longer in the lower than in the higher ones. These cartilages are placed nearer to each other as the ribs descend, which occasions the curvature of the cartilages to be greater.

The length of the ribs increases from the first and uppermost rib, as far down as the seventh; and from that to the twelfth, as gradually diminishes.

The superior of the two plain, or rather hollow surfaces, by which the ribs are articulated to the bodies of the vertebræ, gradually increases from the first to the fourth rib, and is diminished after that in each lower rib.

The distance of their angles from the heads always increases as they descend to the ninth, on account of the greater breadth of the sacrolumbalis muscle *.

The ribs are commonly divided into *true* and *false*, or into vertebral and sterno-vertebral.

The true † costæ are the seven upper ones of each side, the cartilages of which are all gradually longer as the ribs descend, and are joined to the breast-bone; so that being pressed constantly between two bones, they are flatted at both ends, and are thicker, harder, and more liable to ossify, than the other cartilages, that are not subject to so much pressure. These ribs include the heart and lungs; and therefore are the proper or true *custodes* of life.

The cartilages of five inferior ribs of each side do not reach to the sternum; and therefore, wanting the resistance at their fore-part, they are pointed; and, on this account, having less pressure, their substance is softer. The cartilages of

* Winslow, Exposition Anatomique des Os Secs, § 643.

† Γνησαι, germanæ, legitimæ.

these false ribs are shorter as the ribs descend *. To all these five ribs the circular edge of the diaphragm is connected; and its fibres, instead of being stretched immediately transversly, and so running perpendicular to the ribs, are pressed so as to be often, especially in exspiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which these fibres have so frequently to the sides of the thorax, a considerable way above where their extremities are inserted into the ribs, and by the situation of the viscera, always to be observed in a dead subject laid supine, that there is constantly a large concavity formed on each side by the diaphragm within these bastard ribs, in which the stomach, liver, spleen, &c. are contained.

Hence likewise we may learn how to judge better of the seat of several diseases, and to do the

* My father discovered, that the cartilages between the ribs and the breast-bone, with the exception of the cartilage of the first rib, are not fixed to the sternum in the same manner as to the ribs; for the rib which is hollowed, receives the cartilage, and is so firmly united to it, that in the recent subject, they cannot be separated without lacerating the cartilage; but the inner part of the cartilage is tied by a capsular ligament to the edges of the pit of the sternum, and the concave part of the pit is connected by fine cellular threads only to the end of the cartilage, so that the cartilage and sternum, may, after cutting the capsular ligament, be separated from each other *without tearing the cartilaginous fibres.* Hence, when the ribs are moved, the capsular ligament is twisted, and the end of the cartilage rolls upon the sternum.

Vid. Observations on the oblique muscles. Edin. Phil. Trans. vol. 3.

operation of the empyema, and some others, with more safety than we can do, if we follow the common directions.

The first rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore sufficient space is left above it for the subclavian vessels and muscle; and the broad concave surface is opposed to the lungs: In consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.

The head of this rib is not divided into two plane surfaces by a middle ridge, because it is only articulated with the first vertebra of the thorax. Its cartilage is ossified in adults, and is united to the sternum at right angles.

Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the scalenus muscle rises. Farther forward it is flatted, or sometimes depressed by the clavicle.

The cartilages of the fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs *, are con-

* Vid. plate 4th appended to my FATHER'S *Treatise on the Oblique Muscles*, which represents the lengths and curvatures of the seven uppermost ribs, and their cartilages.

tiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former, and to each other by firm ligaments.

The eleventh, and sometimes the tenth rib, has no tubercle for its articulation with the transverse process of the vertebra, to which it is only loosely fixed by ligaments. The fossa in its lower edge, is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs. Its fore-end is smaller than its body, and its short small cartilage is but loosely connected to the cartilage of the rib above.

The twelfth rib is the shortest and straightest. Its head is only articulated with the last vertebra of the thorax; therefore is not divided into two surfaces.

This rib is not joined to the transverse process of the vertebra, and therefore has no tubercle, being often pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed.

The fossa is not found at its under edge, because the vessels run below it.

The fore-part of this rib is smaller than its middle, and has only a very small pointed cartilage fixed to it. To its whole internal side the diaphragm is connected.

The heads and tubercles of the ribs of a new born child have cartilages on them; part of

which become afterwards thin epiphyses. The bodies of the ribs encroach gradually after birth upon the cartilages; so that the latter are proportionally shorter, when compared to the ribs, in adults, than in children.

Here I cannot help remarking the wise providence of our CREATOR, in preserving us from perishing as soon as we come into the world. The ends of the bones of the limbs remain in a cartilaginous state after birth, and are many years before they are entirely united to the main body of their several bones; *whereas the condyles of the occipital bone, and of the lower jaw, are true original processes, and ossified before birth, and the heads and tubercles of the ribs are nearly in the same condition;* and therefore the weight of the large head is firmly supported; the actions of sucking, respiration, &c. which are indispensably necessary for us as soon as we come into the world, are performed without danger of separating the parts of the bones that are most pressed on in these motions: whereas, had these processes of the head, jaw, and ribs, been epiphyses at birth, children must have been exposed to danger of dying by such a separation; the immediate consequences of which would be the compression of the beginning of the spinal marrow, or want of food, or a stop put to respiration.

Sternum.

The *sternum* *, or breast-bone, which varies considerably as to breadth in different persons, is the broad flat bone, or pile of bones, at the fore-part of the thorax. In adults of a middle age, it is composed of three bones, which easily separate after the cartilages connecting them are destroyed. Frequently the two lower bones are found intimately united; and very often in old people, the sternum is a continued bony substance from one end to the other; though we still observe two, sometimes three, transverse lines on its surface; which are marks of the former divisions.

The sternum is broadest and thickest above, and becomes smaller as it descends. The internal surface of this bone is somewhat hollowed for enlarging the thorax; but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards by the true ribs; the round heads of whose cartilages are received into seven smooth pits, formed in each side of the sternum, and are kept firm there by strong ligaments, which on the external surface have a particular radiated texture †. Frequently the cartilaginous fibres thrust themselves into the bony substance

* Στῆθος, Os Pectoris, ensiforme, scutum cordis.

† Ruysch, Catalog. Rar. fig. 9.

of the sternum, and are joined by a sort of suture. The pits at the upper part of the sternum, are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous.

The breast-bone is cellular, with a very thin external plate, especially on its internal surface, where we may frequently observe a cartilaginous crust spread over it *. Whence, with the defence which the muscles give it, and the moveable support it has from the cartilages, it is sufficiently secured from being broken; for it is strong by its quantity of bone; its parts are kept together by ligaments; and it yields enough to elude considerably the violence offered †.

The uppermost piece of the sternum, is somewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a sharp point.

The upper middle-part of this first bone, where it is thickest, is hollowed, to make place for the trachea arteria; though this cavity ‡ is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the sterno-mastoidei muscles pulling it upwards.

On the outside of each tubercle, there is an ob-

* Jac. Sylv. in Galen. de Ossibus, cap. 12.

† Senac, in Memoires de l'Acad. des Sciences, 1724.

‡ Σφαγὴ, Jugulum, Furcula superior.

long cavity, that, in viewing it transversely from before backwards, appears a little convex: Into these glenæ, the ends of the clavicles are received. Immediately below these, the sides of this bone become thinner; and in each a superficial cavity or a rough surface is to be seen, where the first ribs are received or joined to the sternum.

In the side of the under end of this first bone, the half of the pit for the second rib on each side is formed.

The upper part of the surface behind is covered with a strong ligament, which secures the clavicles: this is afterwards to be more particularly taken notice of.

The second or middle division of this bone, is much longer, narrower, and thinner, than the first; but, excepting that it is a little narrower above than below, it is nearly equal all over in its dimensions of breadth or thickness.

In the sides of it are complete pits for the third, fourth, fifth, and sixth ribs, and an half of the pits for the second and seventh. The lines, which are marks of the former division of this bone, being extended from the middle of the pits of one side to the middle of the corresponding pits of the other side.

Near its middle an unossified part of the bone is sometimes found, which, freed of the ligamentous membrane or cartilage that fills it, is describ-

ed as a hole; and in this place, for the most part, we may observe a transverse line, which has made authors divide this bone into two.

When the cartilage between this and the first bone is not ossified, a *manifest motion of this upon the first may be observed in respiration, or in raising the sternum*, by pulling the ribs upwards or distending the lungs with air in a recent subject.

The third bone is much less than the other two, and has only one-half of the pit for the seventh rib formed in it; wherefore it might be reckoned only an appendix of the sternum. In young subjects it is always cartilaginous, and is better known by the name of *cartilago xiphoides* or *ensiformis* *, than any other; though the ancients often called the whole *sternum ensiforme*, comparing the two first bones to the handle and this appendix to the blade of a sword. This third bone is seldom of the same figure, magnitude, or situation in any two subjects; for sometimes it is a plain triangular bone, with one of the angles below, and perpendicular to the middle of the upper side, by which it is connected to the second bone. In other people the point is turned to one side, or obliquely forwards or backwards.

Frequently it is all nearly of an equal breadth, and in several subjects it is bifurcated; whence

* Clypealis, gladialis, mucronata, malum, granatum, scutum stomachi, epiglottalis, cultralis, medium furculæ inferioris, scatiformis, ensiculata.

some writers give it the name of *furcella* or *furcula inferior;* or else it is unossified, in the middle. In the greatest number of adults it is ossified, and tipped with a cartilage; in some one-half of it is cartilaginous, and in others it is all in a cartilaginous state. Generally several oblique ligaments fixed at one end to the cartilages of the ribs, and by the other to the outer surface of the *xiphoid* bone, connect it firmly to those cartilages *.

When the lower end is ossified, and is too much turned outwards or inwards †, or when the conjunction of this appendix with the second bone is too weak ‡, we may suffer much inconvenience.

The sternum is joined by cartilages to the seven upper ribs, unless when the first coalesces with it in an intimate union of substance; and its unequal cavity on each side of its upper end is fitted for the ends of the clavicles.

The sternum most frequently has four round small bones, surrounded with cartilage, in children born at the full time; the uppermost of these, which is the first bone, being the largest.

* Weitbrecht, Syndesmolog. p. 121.

† Rolfinc. Dissert. Anat. lib. 2. cap. 41. Paaw, de Ossib. part 1. cap. 3. & part 3. cap. 3. Codronchi de Prolapsu Cartilagin. mucronat.

‡ Paaw, Ibid. Borrich, Act. Hafn. vol. 5. Ob. 79. Bonnet, Sepulchret. Anat. tom. 2. lib. 3. § 5. Append. ad Obs. 8. & ibid. § 7. Obs. 19.

Two or three other very small bony points are likewise to be seen in several children. The number of bones increases for some years, and then diminishes but uncertainly, till they are at last united into those above described of an adult.

This bone gives origin and insertion to several muscles; sustains the mediastinum, defends the heart and lungs, at the fore-part; and, lastly, by serving as a moveable fulcrum of the ribs, assists considerably in respiration.

When the ribs that are connected by their cartilages to the sternum, or to the cartilages of the true ribs, are acted upon by the intercostal muscles, they must all be pulled from the oblique position which their cartilages kept them in, nearer to right angles with the vertebræ and sternum, because the first or uppermost rib is by much the most fixed of any; and the cartilages making a great resistance to raising the anterior ends of the ribs, their large arched middle parts turn outwards as well as upwards.

The sternum, pressed strongly on both sides by the cartilages of the ribs, is pushed forwards, and that at its several parts, in proportion to the length and motion of its supporters, the ribs; that is, most at its lower end. The sternum and the cartilages, thus raised forwards, must draw the diaphragm connected to them; consequently so far stretch it, and bring it nearer to a plane.

The power that raises this bone and the cartilages, fixes them sufficiently to make them resist the action of the diaphragm, whose fibres contract at the same time, and thrust the viscera of the abdomen downwards. The arched part of the ribs being thus moved outwards, their anterior ends and the sternum being advanced forwards, and the diaphragm being brought nearer to a plane surface, instead of being greatly convex on each side within each cavity of the thorax; it is evident how considerably the cavity, of which the nine or ten upper ribs are the sides, must be widened, and made deeper and longer.

While this is doing in the upper ribs, the lower ones, whose cartilages are not joined to the sternum or to other cartilages, move very differently, though they conspire to the same intention, the enlargement of the thorax: For having no fixed point to which their anterior ends are fastened, and the diaphragm being inserted into them at the place where it runs pretty straight upwards from its origin at the vertebræ, these ribs are drawn downwards by this strong muscle, and by the muscles of the abdomen, which, at this time, are resisting the stretching force of the bowels; while the intercostal muscles are pulling them in the contrary direction, to wit, upwards: The effect therefore of either of these powers, which are antagonists to each other, is very little, as to moving the ribs either up or down; but the muscles of the abdomen, pushed at this time out-

wards by the viscera, carry these ribs along with them. Thus the thorax is not only not allowed to be shortened, but is really widened at its lower part, to assist in making sufficient space for the due distention of the lungs.

As soon as the action of these several muscles ceases, the elastic cartilages extending themselves to their natural situation, depress the upper ribs, and the sternum subsides;—the diaphragm is thrust up by the viscera abdominalia, and the oblique and transverse muscles of the belly serve to draw the inferior ribs inwards at the same time. By these causes, the cavity of the breast is diminished in all its dimensions.

The motions above described of the ribs and sternum, especially of the latter bone, are so small in the mild respiration of a healthy person, that we can scarce observe them; but whenever we designedly increase our respiration, or are obliged to do it after exercise, and in several diseases, they are obvious.

OF THE HEAD.

By the *head* is meant all that spheroidal part which is placed above the first bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* *, helmet, or brain-case, consists of several pieces; which form a vaulted cavity, for lodging and defending the brain and cerebellum, with their membranes, vessels, and nerves.

The cavity of the cranium is proportioned to its contents. Hence such a variety of its size is observed in different subjects; and hence it is neither so broad nor so deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind where the posterior lobes of the brain and cerebellum are contained.

From the peculiar figure of the skull, it is more capacious and stronger; from the flatness of the sides of the cranium, the sphere of vision is extended, and the ears receive a greater quantity of sound, and are less exposed to injuries.

Surfaces of the Skull.

The external surface of the upper part of the cranium is very smooth, and equal, being only co-

* Κογχος, κύτος, κώδεια, σκαφίον, calva, calvaria, cerebri galea, theca & olla capitis, testa capitis, scutella capitis.

vered with the pericranium, the thin frontal and occipital muscles, their tendinous aponeuroses, and with the common teguments of the body; while the external surface of its lower part has numerous risings, depressions and holes, which afford convenient origin and insertion to the muscles that are connected to it, and allow safe passage for the vessels and nerves that run through and near it.

The internal surface of the upper part of the skull is commonly smooth, except where the vessels of the *dura mater* have made furrows in it, while the bones were soft. Surgeons should be cautious when they trepan here, lest, in sawing or raising the bone where such furrows are, they wound these vessels.

In the upper part of the internal surface of several skulls, there are likewise pits of different magnitudes and figures, which seem to be formed by some parts of the brain being more luxuriant and prominent than others, and also by little bodies growing from the dura mater. Where these pits are, the skull is much thinner than any where else, and often rendered diaphanous, the two tables being closely compacted without a diploe; the want of which is supplied by vessels going from the dura mater into a great many small holes observable in the pits.

These vessels are larger, and much more conspicuous than any others that are sent from the dura mater to the skull; as evidently appears

from the drops of blood they pour out, when the skull is raised from the dura mater in a recent subject. The skull being very thin over these pits, surgeons ought to saw cautiously and slowly through the external table of the skull, when they are performing the operation of the trepan; since, in a patient whose cranium has these pits, the dura mater and brain may be injured, before the instrument has pierced near the ordinary thickness of a table of the skull.

The internal base of the skull is extremely unequal, for lodging the several parts and appendices of the brain and cerebellum, and allowing passage and defence to the vessels and nerves that go into, or come out from these parts.

The bones of the cranium are composed of two tables, and intermediate *cancelli*, commonly called their *diploe* *. The external table is thickest; the inner, from its thinness and consequent brittleness, has got the name of *vitrea*. Whence the bad consequences, which so often attend a collection of matter in the diploe, either from an external or internal cause, before any sign of such a collection appears in the teguments that cover the part of the skull where it is lodged †.

The diploe is similar in texture and uses in the skull, as the cancelli in other bones.

* Meditullium, commissura.

† Bonnet, Sepulchret. Anat. lib. 1. § 1. obs. 96,—103.

The diploe in the old, is often so obliterated, that scarce any vestige of it can be seen; neither is it observable in some of the hard bones at the base of the skull. Hence from the bleeding, want of resistance, and change of sound, as marks in the operation of the trepan, it is impossible to know when the instrument has sawed through the first table, and reached the diploe *. The diploe sometimes attains a monstrous thickness, while the tables of the skull are thinner than paper.

The cranium of the adult consists of seven bones only, though eight have been commonly enumerated; six of which are said to be proper, and the other two are reckoned common to it, and to the face. The six proper, are the *os frontis*, two *ossa parietalia*, two *ossa temporum*, and the *os occipitis*. The common are the *os ethmoides* and *os sphenoides*.

The os frontis forms the whole fore-part of the vault; the two ossa parietalia form the upper and middle part of it; the ossa temporum compose the lower part of the sides; the os occipitis makes the whole hinder part, and some of the base; the os ethmoides is placed in the fore-part of the base, and the os sphenoides is in the middle of it.

* Bartholin. Anat. reform. lib. 4. cap. 4.

These bones are joined to each other by five *sutures;* the names of which, are the *coronal, lambdoid, sagittal,* and two *squamous.*

The *coronal** suture is extended over the head, from within an inch or so of the external canthus of one eye, to the like distance from the other; which being near the place where the ancients wore their *vittæ, coronæ,* or garlands, this suture has hence got its name. Though the indentations of this suture are conspicuous in its upper part, yet an inch or more of its end on each side has none of them; for it is squamous and smooth there.

The *lambdoidal*† suture begins some way below, and farther back than the vertex or crown of the head, whence its two legs are stretched obliquely downwards, and to each side in form of the Greek letter Δ, and are now generally said to extend themselves to the base of the skull; but formerly anatomists‡ reckoned the proper lambdoid suture to terminate at the squamous sutures, and what is extended at an angle down from that on each side, where the indentations are less conspicuous than in the upper part of the suture, they called *additamentum suturæ lambdoidis*§.

* Στεφανεῖα, arcualis, puppis.

† Laudæ, proræ, hypsyloides.

‡ Vesal. Anat. lib. 1. cap. 6.

§ Lambdoides harmonialis, lambdoides inferior, occipitis corona.

This suture is sometimes very irregular, being made up of a great many small sutures which surround so many little bones that are generally larger and more conspicuous on the external surface of the skull, than internally. These bones are generally called *triquetra* or *wormiana;* but some other name ought to be given them, for they are not always of a triangular figure; and older anatomists * than OLAUS WORMIUS † have described them. The anatomists generally agree, that their formation is owing to a greater number of points than ordinary of ossification in the skull, or to the ordinary bones of the cranium not extending their ossification far enough or soon enough; in which case, the unossified interstice between such bones, begins a separate ossification in one or more points; from which the ossification is extended to form as many distinct bones as there were points, that are indented into the large ordinary bones, and into each other.

Ossa triquetra are sometimes seen in other sutures, as well as in the lambdoid ‡, and some-

* EUSTACH. Ossium Examen. BAUHIN. Theat. Anat. lib. 3. cap. 5. PAAW, in Hippocrat. de vulner. cap. p. 56.

† BAUHIN & PAAW, ibid. BARTHOLIN. Anat. reform. lib. 4. cap. 5. HILDAN. Epistol. 65.

‡ See Examples in VESAL. lib. 1. cap. 6. fig. 4. PAAW in Hippocrat. de cap. Vuln. BARTHOLIN. Hist. Anat. Cent. 1. Hist. 51. RUSCH. Mus. Anat. SUE, Trad. d'Osteolog. p. 47.

times in one table of the skull, but not in the other *.

The *sagittal* suture † is placed longitudinally in the middle of the upper part of the skull, and commonly terminates at the middle of the coronal and of the lambdoid sutures; between which it is said to be placed, as an arrow is between the string and bow. This suture is frequently continued through the middle of the os frontis, down to the root of the nose; which some ‡ say, oftener happens in women than men; but others § allege, that it is to be met with more frequently in male skulls, than in female: Among the skulls which I have seen thus divided, the female are the most numerous.

In some heads, one or two of the sutures only dissappear. In others there is no vestige of any of them.

The *squamous agglutinations* or *false sutures* ||, are one on each side, a little above the ear, of a semicircular figure, formed by the overlopping

*. Hunauld. in Mem. de l'Acad. des Sciences, 1730.

† Ῥαβδοειδὴς, ὀβελαία, ἐπιζυγνυσα, Instar virgae, nervalis, instar teli, instar veru, secundum capitis longitudinem prorepens, conjungens, columnalis, recta, acualis.

‡ Riolan. Coment. de Ossib. cap. 8.

§ Vesal. lib. 1. cap. 6. et in Epitome.

|| Λεπιδοειδὴ, προσκολλήματα, κροταφίαι, Temporales, corticales, mendosæ, harmoniales, commissuræ in unguem.

(like one scale upon another) of the upper part of the temporal bones on the lower part of the parietal, where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear till the bones are separated. In some skulls indeed the indentations here are as conspicuous externally as in other sutures *; and what is commonly called the posterior part of this squamous suture, always has the evident serrated form; and therefore is reckoned by some † a distinct suture, under the name of *additamentum posterius suturæ squamosæ*. I have seen two squamous sutures on the same temple, with a semicircular piece of bone between them ‡.

The true squamous sort of suture is not confined to the conjunction of the temporal and parietal bones, but joins all the edges of the bones on which each temporal muscle is placed §: For the two parts of the sphenoidal suture which are continued from the anterior end of the common squamous suture just now described, of which one runs perpendicularly downwards, and the other horizontal-

* Columb. de re Anat. lib. 1. cap. 4. Dionis, Anat. 3. Demonst. des Os.

† Albin. de Ossib. § 54.

‡ Sue, Trad. d'Osteolog. p. 48.

§ Vesal. Anat. lib. 1. cap. 6. Winslow, Mem. de l'Acad. des Sciences, 1720.

ly forwards, and also the lower part of the coronal suture already taken notice of, may all be justly said to pertain to the squamous suture. The squamous form is also more convenient here; because such thin edges of bones, when accurately applied one to another, have scarce any rough surface, to obstruct or hurt the muscle in its contraction; which is still further provided for, by the manner of laying these edges on each other; for, in viewing their outside, we see the temporal bones covering the sphenoidal and parietal, and this last supporting the sphenoidal, while both mount on the frontal: From which disposition it is evident, that while the temporal muscle is contracting, which is the only time it presses strongly in its motion on the bones, its fibres slide easily over the external edges. Another advantage still in this is, that all this bony part is made stronger by the bones thus supporting each other.

The bones of the skull are joined to those of the face, by *schyndelesis* and *sutures*. The schyndelesis is in the partition of the nose. The sutures said to be common to the cranium and face are five, viz. the *ethmoidal*, *sphenoidal*, *transverse*, and two *zygomatic*.

The *ethmoidal* and *sphenoidal* sutures surround the bones of these names; and in some places help to make up other sutures, particularly the squamous and transverse; and in other parts there is but one suture common to these two bones.

The *transverse* suture is extended quite cross the face, from the external canthus of one orbit to the same place of the other, by sinking from the canthus down the outside of the orbit to its bottom; then mounting upon its inside, it is continued by the root of the nose down the internal part of the other orbit, and rises up again on its outside to the other canthus. It may be here remarked, that there are some interruptions of this suture in the course I have described; for the bones are not contiguous every where, but are separated, to leave holes and apertures, to be mentioned hereafter.

The *zygomatic* sutures are one on each side, being short, and slanting from above obliquely downwards and backwards, to join a process of the cheek bone to one of the temporal bones, which advances towards the face; so that the two processes thus united, form a sort of bridge, or jugum, under which the temporal muscle passes; on which account the processes, and suture joining them, have been called zygomatic.

It must be observed, that the indentations of the sutures are not so distinct on the inside of the cranium, as on the outside; the bones seeming almost joined in a straight line; nay in some skulls, the internal surface is found entire, while the sutures are manifest without; which may possibly be owing to the less extent of the concave than of the convex surface of the cranium,

whereby the fibres of the internal side would be stretched farther out at the edges of the bones, than the exterior ones, if they were not resisted. The resistances are the fibres of the opposite bone, the parts within the skull, and the diploe; of which the last being the weakest, the most advanced fibres or serræ run into it, and leave the contiguous edges equal, and more ready to unite: whereas the serræ of the external table have space enough for their admission between the fibres of the opposite bone; and therefore remain of the indented form, and are less liable to the concretion, whereby the sutures are obliterated *. By this mechanism, there is no risk of the sharp points of the bones growing inwards, since the external serræ of each of the conjoined bones rest upon the internal smooth-edged table of the other; and external forces applied to these parts are strongly resisted, because the sutures cannot yield, unless the serrated edged of the one bone, and the plain internal plate of the other are broken †.

The advantages of the sutures of the cranium are these:

1. That the bones which are at some distance from each other at birth, might then yield, and allow to the head a change of shape, accommodated to the passage it is engaged in. Whence, in hard labour of childbed, the

* Hunauld, Memoires de l'Acad. des Sciences, 1730.
† Winslow, Memoires de l'Acad. des Sciences, 1720.

bones of the cranium sometimes overlap each other *.

2. That this capsula is more easily formed and extended into a spherical figure, than if it had been one continued bone.

3. As there is a freer communication of the vessels without, and of those within the skull, larger here than in any other part of the cranium, according to some moderns; and therefore cucuphæ, fomentations, cataplasms, cephalic plasters, blisters, are applied, and issues are eroded, or cut in the head, at those places where the sutures are longest in forming, and where the connexion of the bones is afterwards loosest, for the cure of a phrenitis, mania, inveterate headach, epilepsy, apoplexy, and other diseases of the head.

4. That the dura mater may be more firmly suspended by its processes, which insinuate themselves into this conjunction of the bones; for doing this equally, and where the greatest necessity of adhesion is, the sutures are disposed at nearly equal distances, and the large reservoirs of blood, the sinuses, are under or near them.

5. That fractures might be prevented from reaching so far as they would in a continued bony substance.

6. That the connexion at the sutures being capable

* According to Mr Gibson of Manchester, the bones of the skull extend chiefly at the edges, and the sutures admit of the intervention of a vascular menbrane and when ossification has been completed, the sutures are obliterated.

of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened *. And it seems reasonable to believe, that the opening of the sutures was of great benefit to several others who were rather judged to have been hurt by it †: for we must think, that the consequences of such a force acting upon the brain, as was capable of thrusting the bones asunder, must have been fatal, unless it had been thus yielded to; and thus I have seen the acute converted into the chronic hydrocephalus.

Os Frontis.

The *os frontis* ‡ is named from its being the only bone of that part of the face we call the *forehead*, though it reaches a good deal further. It has some resemblance in shape to the shell of the concha bivalvis commonly called the *cockle;* for the greatest part of it is convex externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make it of an irregular figure.

* Ephemerid. Germanic. Dec. 1. Ann. 4. & 5. Observ. 33.

† Ephemerid. Germ. Dec. 2. Ann. 9. Obs. 230. Ibid. cent. 10. Obs. 31. VANDER LINDEN, Medicin. Phys. cap. 8. art. 4. § 16. HILDAN. Observ. cent. 1. Obs. 1; Cent. 2. Obs. 7. BAUHIN. Theat. Anat. lib. 3. cap. 6. PLECHIN. Observ. lib. 2. Observ. 39.

‡ Μετώπε, Βρῖγμα, Coronale, inverecundum, puppis, sensus communis, sincipitis.

The external surface of the os frontis is smooth at its upper convex part; but several processes and cavities are observable below: For, at each angle of each orbit, the bone juts out, to form four processes, two internal, and as many external; which, from this situation, may well enough be named *angular*. Between the internal and external angular processes of each side, an arched ridge is extended, on which the eye-brows are placed.

Very little above the internal end of each of these superciliary ridges, a protuberance may be remarked, in most skulls, where there are large cavities, called *sinuses*, within the bone. Betwixt the internal angular processes, a small process rises, which forms some share of the nose, and thence is named *nasal*.

Some observe a protuberant part on the edge of the bone behind each external angular process, which they call *temporal* processes; but these are inconsiderable.

From the under part of the superciliary ridges, the frontal bone runs a great way backwards; which parts may justly enough be called *orbitar* processes. These are concave externally, for receiving the globes of the eyes, with their muscles, fat *, &c.

* For a particular account of the orbits, see CAMPER, Diss. Phys. de quibusdam oculi partibus; and the 7th chap. of ZINN, Descrip. anat. oculi humani.

In each of the orbitar processes, behind the middle of the superciliary ridges, a considerable sinuosity is observed, where the *glandula innominata Galeni* or *lachrymalis* is lodged.

Behind each internal angular process, a small pit may be remarked, where the cartilaginous pully of the *musculus obliquus major* of the eye is fixed.

Betwixt the two orbitar processes, there is a large discontinuation of the bone, into which the cribriform part of the *os ethmoides* is incased.

The frontal bone frequently has little cavern's formed in it here, where it is joined to the ethmoid bone.

Behind each external angular process, the surface of the frontal bone is considerably depressed, where part of the *temporal* muscle is placed.

The *foramina*, or *holes*, observable on the external surface of the frontal bone, are three in each side. There is one in each superciliary ridge, a little removed from its middle towards the nose; through which a twig of the *ophthalmic* branch of the fifth pair of nerves passes out of the orbit, with a small artery from the internal carotid, to be distributed to the teguments and muscles of the fore-head.

These vessels, in some skulls, make furrows in the os frontis, especially in the bones of children, as has also been observed of another considerable

vessel of this bone near its middle *; and therefore we ought to beware of transverse incisions on either side of the os frontis, which might either open these vessels or hurt the nerves, while they are yet in part within the bone; for, when vessels are thus wounded, it is difficult to stop the hæmorrhagy, because the adhesion of a part of the artery to the bone, hinders its contraction, and consequently styptics can have little effect; the sides of the furrow keep off compressing substances from the artery; and we would wish to shun cauteries or escharotics, because they make the bone carious; and nerves, when thus hurt, sometimes produce violent symptoms.

But, to return to the *superciliary foramina*, we must remark, that often, instead of a hole, a notch only is to be seen: Nay, in some skulls, scarce a vestige even of this is left; in others, both hole and notch are observable, when the nerve and artery run separately. Frequently a hole is found on one side, and a notch on the other; at other times we see two holes; or there is a common hole without, and two distinct entries internally †.

Near the middle of the inside of each orbit, hard by, or in the transverse suture, there is a small hole for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a

* Ruysch, Mus. Anat. Theca D. Reposit. 4. No. 3.

† Vid. the annexed plates of crania.

branch of the ophthalmic artery. This hole is sometimes entirely formed in the os frontis; in other skulls, the sides of it are composed of this last bone, and of the os planum. It is commonly known by the name of *orbitarium internum*, though *anterius* should be added, because of the next, which is commonly omitted. This, which may be called *orbitarium internum posterius*, is such another as the former; only smaller, and about an inch deeper in the orbit: Through it a small branch of the ocular artery passes to the nose.

Besides these six, there are a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eye-brows. Most of these penetrate no further than the sinuses, or than the diploe, if the sinuses are wanting; though sometimes I have seen this bone so perforated by a vast number of these small holes, that, placed between the eye and a clear light, it appeared like a sieve.

In the orbit of the generality of skeletons, we may observe one, two, or more holes, which allow a passage to a hog's bristle through the skull. The place, size, and number of these, are however uncertain: They generally serve for the transmission of small arteries or nerves.

The internal surface of the os frontis, is concave, except at the orbitar processes, which are convex, to support the anterior lobes of the brain. This surface is not so smooth as the external; for

the larger branches of the arteries of the dura mater, make some furrows in its sides and back parts. The sinuosities from the luxuriant risings of the brain, mentioned when describing the general structure of the cranium, are often very observable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.

Through the middle of this internal surface, where always in children, and sometimes in old people, the bone is divided, either a ridge stands out, to which the upper edge of the falx is fastened, or a furrow runs, in which the upper side of the superior longitudinal sinus is lodged: on both these accounts chirurgical authors justly discharge the application of the trepan here. The reason of this difference in skulls, is alleged by some authors to be this, That in thin skulls the ridge strengthens the bones, and in thick ones there is no occasion for it. To this way of accounting for this phænomenon, it may justly be objected, that generally very thick skulls have a large spine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of complete ossification of those parts in different subjects: For if the two sides of this bone meet before they arrive at their utmost extent of growth, they unite very firmly, and all their fibres endeavour to stretch themselves out where the least resistance is, that is, between the hemispheres of the brain.

Immediately at the root of this ridge or furrow there is a small hole, which sometimes pierces through the first table, and, in other skulls, opens into the superior sinus of the ethmoid bone within the nose. In it a little process of the falx is lodged, and a small artery, and sometimes a vein runs *; and the superior longitudinal sinus begins here. This hole, however, is often not entirely proper to the os frontis; for in several skulls, the lower part of it is formed in the upper part of the base of the crista galli, which is a process of the ethmoid bone †.

The os frontis is composed of two tables, and an intermediate diploe, as the other bones of the cranium are, and, in a middle degree of thickness between the os occipitis and the parietal bones; is pretty equally dense all through, except at the orbitar processes, where, by the action of the eye on one side, and pressure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the meditullium is entirely obliterated. Since in this place there is so weak a defence for the brain, the reason appears why fencers esteem a push in the eye mortal ‡.

* Morgagn. Adversar. 6. Animad. 31.

† Ingrass. Comment. in Galen. de Ossib. cap. 1. comment. 8.

‡ Ruysh. Observ. Anat. Chir. Observ. 54. Diemerbroeck. Anat. lib. 3. cap. 10. Bonet, Sepulch. Anat. lib. 4. § 3. Observ. 17.

The diploe is also exhausted in that part above the eye-brows, where the two tables of the bone separate, by the external being protruded outwards, to form two large cavities, called sinus frontales *. These are divided by a middle perpendicular bony partition. Their capacities in the same subject are seldom equal; in some the right, in others the left is largest. And in different bones their size is as inconstant; nay, I have examined some, where they were entirely wanting; which oftener happens in such as have a flat fore-head, and whose sagittal suture is continued down to the nose, than in others †. In some skulls, besides the large perpendicular septum, there are several bony pillars, or short partitions found in each sinus; in others these are wanting. For the most part the septum is entire; at other times it is discontinued, and the two sinuses communicate. When the sinuses are seen in such skulls as have the frontal bone divided by the sagittal suture, the partition dividing these cavities, is evidently composed of two plates, which easily separate. Each sinus commonly opens by a roundish small hole, at the inner and lower part of the internal angular processes, into a sinus formed in the nose, at the upper and back part of the os unguis; near to which there are also some other

* For a more particular account of these sinuses, vid. BLUMENBACH, and DESCHAMPS.

† FALLOP. Exposit. de Ossibus, cap. 13.

small sinuses of this bone *, the greater part of which open separately nearer the septum narium, and often they terminate in the same common canal with the large ones.

These and the other cavities which open into the nose, increase the sound of our voice, and render it more melodious, by serving as so many vaults to resound the notes. Hence, people labouring under a coryza, or stoppage of the nose from any other cause, when they are by the vulgar, though falsely, said to speak through their nose, have such a disagreeable harsh voice. The liquor separated in the membrane of these sinuses, drills down upon the membrane of the nose to keep it moist.

From the description of these sinuses, it is evident, how useless, nay, how pernicious it must be, to apply a trepan on this part of the skull; for this instrument, instead of piercing into the cavity of the cranium, would reach no farther than the sinuses; or, if the inner table was perforated, any extravasated blood that happened to be within the skull, would not be discharged outwardly, but would fall into the sinuses, there to stagnate, and stimulate the sensible membranes.

The membrane lining these sinuses is so sensible, that inflammations of it must create violent torture †;

* Cowper, in Drake's Anthropolog. Book 3. chap. 10.

† Fernel, Partholog. lib. 5. cap. 7. Saltzman, Decur. Observ. 10.

and worms or other insects, must give great uneasiness *.

The upper circular part of the os frontis is joined to the ossa parietalia, from one temple to the other, by the coronal suture. From the termination of the coronal suture to the external angular processes, this bone is connected to the sphenoid by the sphenoidal suture. At the external canthi of the eyes, its angular processes are joined by the transverse suture to the ossa malarum, to which it adheres one-third down the outside of the orbits; whence to the bottom of these cavities, and a little up on their internal sides, these orbitar processes are connected to the sphenoidal bone by that same suture. In some few skulls, however, a discontinuation of these two bones appears at the upper part of the long slit, near the bottom of the orbit. On the inside of each orbit, the orbitar process is indented between the cribriform part of the ethmoid bone, and the os planum and unguis. The transverse suture afterwards joins the frontal bone to the superior nasal processes of the ossa maxillaria superiora, and to the nasal bones. And, lastly, its nasal process is connected to the nasal lamella of the ethmoid bone.

The frontal bone serves to defend and support the anterior lobes of the brain. It forms a con-

* Fernel, Partholog. lib. 5. cap. 7. Bartholin. Epistol. Medic. cent. 2. Epist. 74. Hist. de l'Acad. des Sciences, 1708 and 1733.

siderable part of the cavities that contain the globes of the eyes, helps to make up the septum narium, organ of smelling, &c. From the description of the several parts, the other uses of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the superciliary holes are not formed; often a small round piece of each orbitar process, behind the superciliary ridge, is not ossified, and there is no sinus to be seen within its substance.

Ossa Parietalia.

Each of the two ossa parietalia *, or bones serving as walls to the encephalon, is an irregular square; its upper and fore sides being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone. The angle formed by this upper side, and the fore one is so extended, as to have the appearance of a process.

The external surface of each os parietale is convex. Upon it, somewhat below the middle height of the bone, there is a transverse arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have strong prints of muscles, we see a great many converg-

* Κορυφῆς, Paria, syncipitis, verticis, arcualia, nervalia, cogitationis, rationis, bregmatis, madefactionis.

ing furrows, like so many *radii* drawn from a circumference towards a centre. From this ridge of each bone the temporal muscle rises; and, by the pressure of its fibres, occasions the furrows just now mentioned. Below these, we observe, near the semicircular edges, a great many risings and depressions, which are joined to like inequalities on the inside of the temporal bone, to form the squamous suture. The temporal bone may therefore serve here as a buttress, to prevent the lower side of the parietal from starting outwards when its upper part is pressed or struck *.

Near the upper sides of these bones, towards the hind part, is a small hole in each, through which a vein passes from the teguments of the head to the longitudinal sinus. Sometimes I have seen a branch of the temporal artery pass through this hole, to be distributed to the upper part of the falx, and to the dura mater at its sides, where it had frequent anastomoses with the branches of the arteries derived from the external carotids, which commonly have the name of the arteries of the dura mater, and with the branches of the internal carotids which serve the falx. In several skulls, one of the ossa parietalia has not this hole; in others, there are two in one bone; and in some not one in either. Most frequently this hole is through both tables; at other times the external table only is perforated. The knowledge of the

* Hunauld in Mem. de l'Acad. des Sciences, 1730.

course of these vessels, may be of use to surgeons, when they make any incision near this part of the head; lest, if the vessels are rashly cut near the hole, they shrink within the substance of the bone, and so cause an obstinate hæmorrhagy, which neither ligatures nor medicines can stop.

On the inner concave surface of the parietal bones, there are a great many deep furrows, disposed somewhat like the branches of trees; which are largest and deepest at the lower edge of each os parietale, especially near its anterior angle, where sometimes a full canal is formed: They afterwards divide into small furrows, in their progress upwards. In some skulls, a large furrow begins at the hole near the upper edge, and divides into branches, which join with those which come upwards, shewing the communications of the upper and lower vessels of the dura mater. In these furrows we frequently see passages into the diploe; and sometimes I have observed canals going off, which allowed a small probe to pass some inches into the bony substance. Some* tell us, that they have observed these canals piercing the bone towards the occiput. On the inside of the upper edge of the ossa parietalia, there is a large sinuosity, frequently larger in the bone of one side than of the other, where the upper part of the falx is fastened, and the superior longitudinal sinus is lodged. Generally, part of the lateral sinuses

* Cowper, Anatam. Explic. of XC Tab. Fig. 1.

makes a depression near the angle formed by the lower and posterior sides of these bones; and the pits made by the prominent parts of the brain are to be seen in no part of the skull more frequent, or more considerable, than in the internal surface of the parietal bones.

The ossa parietalia are amongst the thinnest bones of the cranium.

These bones are joined at their fore-side to the os frontis by the coronal suture; at their long inferior angles, to the sphenoidal bone, by part of the suture of this name; at their lower edge, to the ossa temporum, by the squamous suture and its posterior additamentum; behind, to the os occipitis, or ossa triquetra, by the lambdoid suture; and above, to one another, by the sagittal suture.

In a child born at the full time, none of the sides of this bone are completed: and there never is a hole in the ossified part of it near to the sagittal suture.

A large unossified ligamentous part of the cranium is observable between the parietal bones, and the middle of the divided os frontis of new-born children, called by the vulgar the open of the head, *bregma* * or *fons pulsatilis*, on account of the pulsation of the brain felt through this flexible ligamentous cartilaginous substance. Hence very frequently the parietal bones are called *ossa bregmatis*.

* Palpitans vertex, foliolum, folium, triangularis lacuna.

The upper middle part of the head of a child, in a natural birth, being what presents itself first at the os uteri *, an accoucheur may reach the bregma with his finger, when the os uteri is a little opened. If the bregma is stretched, and the pulsation of the brain is felt through it, the child is certainly alive: But if it is shrivelled and flaccid, without any observable pulsation in it, there is some reason to suspect the child to be very weak, or dead. Those who practise midwifery, should therefore examine the state of the bregma accurately.

All the bregma is generally ossified before seven years of age.

Ossa Temporum.

The OSSA TEMPORUM †, so named, say authors, from the hair's first becoming gray on the temples, are each of them equal and smooth above, with a very thin semicircular edge; which, from the manner of its connexion with the neighbouring bones, is distinguished by the name of *os squamosum*. Behind this, the upper part of the temporal bone is thicker, and more unequal, and is sometimes de-

* BURTON'S Midwifery, § 51. SMELLIE'S Midwifery, Book 1. chap. 1. § 5.

† Κόρτκφῶν, κορσῶν, κορρων, λεπιδοθειδῆ, πολυειδῆ, λιθοειδῆ, temporalia, lapidosa, mendosa, dura, arcualia, tymparum, armalia, saxea, parietalia.

scribed as a distinct part, under the name of *pars mammillaris* *.

Towards the base of the skull, the temporal bone appears very irregular and unequal; and this part, instead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard substance, extended horizontally forwards and inwards, which in its progress becomes smaller, and is commonly called *os petrosum.*

Three external processes of each temporal bone are generally described.

The first placed at the lower and hind part of the bone, from its resemblance to a nipple, is called *mastoides* or *mammillaris.* It is not solid, but within is composed of cancelli, or small cells, which have a communication with the large cavity of the ear, the drum; and therefore sounds, being multiplied in this vaulted labyrinth, are increased, before they are applied to the immediate organ of hearing. Into the mastoid process, the sternomastoideus muscle is inserted; and to its back-part, where the surface is rough, the trachelomastoideus, and part of the splenius are fixed. About an inch farther forward, the second process begins to rise out from the bone; and having its origin continued obliquely downwards and forwards for some way, it becomes smaller, and is stretched forwards to join with the *os malæ;* they

* Albin. de Ossib. § 26.

together forming the bony *jugum*, under which the temporal muscle passes. Hence this process has been named *zygomatic* *. Its upper edge has the strong aponeurosis of the temporal muscle fixed into it; and its lower part gives rise to a share of the *masseter*. The fore-part of the base of this process is an oblong tubercle, which in a recent subject is covered with a smooth polished cartilage, continued from that which lines the cavity immediately behind this tubercle.

From the under craggy part of the *os temporum*, the third process stands out obliquely forwards. The shape of it is generally said to resemble the ancient *stylus scriptorius;* and therefore it is called the *styloid* process †. Some authors ‡ however contend, that it ought to be named *steloid*, from its being more like to a pillar. Several muscles have their origin from this process, and borrow one-half of their name from it; as *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus;* to it a ligament of the os hyoides is sometimes fixed; and another is extended from it to the inside of the angle of the lower jaw.

This process is often even in adults not entirely ossified, but is ligamentous at its root, and some-

* Καγχες, Paris, ansæ ossium temporum, ossa arcualia, paria, jugalia, conjugalia.

† Γραφοειδη, βελονοειδη, πληκτρον, Os calaminum, sagittale, clavale, acuale, calcar capitis.

‡ Galen, de usu part. lib. 2. cap. 4. Fallop. Observ. Anatom.

times is composed of two or three distinct pieces. Round the root of it, especially at the fore-part, there is a remarkable rising of the os petrosum, which some have esteemed a process; and, from the appearance it makes with the styliform, have named it *vaginalis*. Others again have, under the name of *auditory* process, reckoned among the external processes that semicircular ridge, which, running between the root of the mastoid and zygomatic processes, forms the under-part of the external *meatus auditorius*.

The sinuosities or depressions on the external surface of each os temporum are these: A long fossa at the inner and back-part of the root of the mammary process, where the posterior head of the digastric muscle has its origin. Immediately before the root of the zygomatic process, a considerable hollow is left, for lodging the crotaphite muscle.

Between the zygomatic, auditory and vaginal processes, a large cavity is formed; through the middle of which, from top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed.

The fore-part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the condyle of the jaw; and in the back-part, a small share of the parotid gland, and a cellular fatty substance, are lodged.

At the inside of the root of the styloid apophyse, there is a thimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral sinus, is lodged. And as the sinuses of the two sides are frequently of unequal size; so one of these cavities is as often larger than the other *. Round the external meatus auditorius, several sinuosities are formed for receiving the cartilages and ligaments of the ear, and for their firm adhesion.

The holes that commonly appear on the outside of each of these bones, and are proper to each of them, are five:

The *first*, situated between the zygomatic and mastoid processes, is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus* †.

The *second* gives passage to the *portia dura* of the seventh pair of nerves, and, from its situation between the mastoid and styloid processes, is called *foramen stylo-mastoideum* ‡.

Some way before, and to the inside of the styloid process, is the *third* hole; the canal from which runs first upwards, then forwards, and receives into it the internal carotid artery, and the beginning of the intercostal nerve: where this canal is about to make the turn forwards, one, or

* Hunauld, in Mem. de l'Acad. des Sciences, 1730.

† Πόρος της ακοὴς, οπὴ τῶν ὠτῶν. Fenestra aurium.

‡ Aquæductus Fallopii.

sometimes two very small holes go off towards the cavity of the ear, called *tympanum;* through these VALSALVA * affirms the proper artery or arteries of that cavity are sent.

On the anterior edge of this bone, near the former, a *fourth* hole is observable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the tympanum. This, in the recent subject, is continued forward and inward, from the parts which I mentioned just now as its orifice in the skeleton, to the side of the nostrils; being partly cartilaginous, and partly ligamentous. The whole canal is named, *iter a palato ad aurem*, or *eustachian tube*.

On the external side of the bony part of this canal, and at the top of the chink in the cavity that receives the condyle of the lower jaw, is the course of the little nerve, said commonly to be reflected from the lingual branch of the fifth pair, till it enters the tympanum, to run across this cavity, and to have the name of *chorda tympani*.

The *fifth* hole is very uncertain, appearing sometimes behind the mastoid process; sometimes it is common to the temporal and occipital bones; and in several skulls there is no such hole. The use of it, when found, is for the transmission of a vein from the external teguments to the lateral

* De Aure humana, cap. 2. § 22. et tab. 7. fig. 1.

sinus: But, in some subjects, a branch of the occipital artery passes through this hole, to serve the back-part of the dura mater; in others, I have seen two or three such holes: But they are oftener wanting than found.

The internal surface of the ossa temporum is unequal; the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it is irregularly marked with the convolutions of the middle-part of the brain, and with furrows made by the branches of the arteries of the dura mater.

From the under-part of this internal surface, a large transverse hard craggy protuberance runs horizontally inwards and forwards, with a sharp edge above, and two flat sides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the dura mater is fixed.

Sometimes a small bone, a-kin to the sesamoid, is found between the small end of this petrous process, and the sphenoid bone*.

Towards the back-part of the inside of the os temporum, a large deep fossa is conspicuous, where the lateral sinus lies; and frequently on the top

* Riolan, Comment. de Ossib, cap. 32. Winslow, Expoiition Anatomique de corps humain, trait des os secs, § 266.

of the petrous ridge, a furrow may be observed, where a small sinus is situated.

The internal proper foramina of each of these bones are, *first*, the internal *meatus auditorius* in the posterior plain side of the petrous process. This hole soon divides into two; one of which, is the beginning of the *aqueduct* of *Fallopius;* the other ends in several very small canals *, that allow a passage to the branches of the *portio mollis* of the seventh pair of nerves, into the *vestibule* and *cochlea.* Through it also an artery is sent, to be distributed to the organ of hearing. The *second* hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the second branch of the fifth pair of nerves, which joins the portio dura of the auditory nerve, while it is in the aqueduct †, small branches of bloodvessels accompanying the nerves, or passing through smaller holes near this one. The passage of the cutaneous vein into the lateral sinus, or of a branch of the occipital artery, is seen about the middle of the large fossa for that sinus; and the orifice of the canal of the carotid artery, is evident at the under-part of the point of the petrous process.

Besides these proper holes of the temporal bones which appear on their external and internal surfaces, there are two others in each side, that are

* Dr Monro 2d on the Nervous System, tab. xxiv.

† Dr Monro 2d on the Ear.

common to this bone and to the occipital and sphenoidal bones. The parts contained within the os petrosum of the skeleton, will be afterwards described.

The temporal bones are joined above to the parietal bones by the squamous sutures, and their posterior additamenta: Before, to the sphenoid bone at the suture of that name; to the cheek-bones at the zygomatic sutures: Behind, to the occipital bone, at the lambdoid suture and its additamenta; and they are articulated with the lower jaw, in the manner which shall be described when this bone is examined.

In an infant, a small fissure is to be observed between the thin upper part, and the lower craggy part of each of these bones; which points out the recent union of these parts. Neither mastoid nor styloid processes are yet to be seen. Instead of a bony funnel-like external meatus auditorius, there is only a smooth bony ring, within which the membrane of the drum is fastened. At the entry of the eustachian tube, the side of the tympanum is not completed. A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whose orifice the interior semicircular canal of the ear is stretched; and some way below this, the posterior semicircular canal also appears manifestly.

* For a full description of the osseous part of the ear, Vid. vol. 3. of this work.

Os Occipitis.

The Os Occipitis *, so called from its situation, is convex on the outside, and concave internally. Its figure is an irregular square, or rather rhomboid; of which the angle above is generally a little rounded; the two lateral angles are more finished, but obtuse; and the lower one is stretched forward in form of a wedge, and thence is called by some the *cuneiform* process. If one would, however, be very nice in observing the several turns which the edges of the os occipitis make, five or seven sides, and as many angles of this bone, might be described.

The external surface is convex, except at the cuneiform apophyse, where it is flatted.

At the base of this triangular process, on each side of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to serve for the articulation of this bone with the first vertebra of the neck.

The smooth surface of each of these condyloid processes is longest from behind forwards, where, by their oblique situation, they come much nearer to each other than they are at their back-part. Their inner sides are lower than the external, by which they are prevented from sliding to either

* "Ivor, Basilare, proræ, memoriæ, pixidis, fibrosum, nervosum, lambdæ.

side out of the cavities of the first vertebra *. In some subjects each of these plain smooth surfaces seems to be divided by a small rising in its middle, and the lower edge of each condyle next the great foramen is discontinued about the middle, by an intervening notch: Whence some † allege, that each of these apophyses is made up of two protuberances. Round their root a small depression and spongy roughness is observable, where the ligaments for surrounding and securing their articulations adhere.

The motion of the head is performed on the condyles, but its centre of gravity does not fall between them, but further forward; hence the muscles which pull the head back, must be in a constant state of contraction; else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles. This seeming disadvantageous situation of the condyles, gives sufficient space for the cavities of the mouth and fauces, and for lodging a sufficient number of muscles, which commonly serve for other uses; but may at pleasure be directed to act on the head, and then act with an advantageous lever, so as to be able to sustain a considerable weight

* GALEN, de usu part. lib. 12. cap. 7.

† DIEMERBROECK, Anat. lib. 9. cap. 6.

appended, or other force applied, to pull the head back.

Somewhat more externally than the condyles, there is a small rising and semilunated hollow in each side, which make up part of the holes, common to the occipital and petrous bones.

Immediately behind this, on each side, a scabrous ridge is extended from the middle of the condyle, towards the root of the mastoid process. Into this ridge the musculus lateralis is inserted. About the middle of the external convex surface, a large arch runs cross the bone; from the upper lateral parts of which the occipital muscles have their rise; to its middle the trapezii are attached; and half way between this and the great hole, a lesser arch is extended.

In the hollows between the middle of these arches, the complexi are inserted; and in the depressions more external and further forward than these, the splenii are inserted.

Between the middle of the lesser arch and the great hole, the little hollow marks of the recti minores appear; and on each side of these, the fleshy insertions of the obliqui superiores and recti majores make depressions.

Through the middle of the two arches a small sharp spine is placed, which serves as a sort of partition between the muscles of different sides, or rather is owing to the action of the muscles depressing the bone on each side of it, while this part is free from their compression. These prints

of the muscles on this bone are very strong and plain in some subjects, but are not so distinct in others.

All round the great foramen the edges are unequal, for the firmer adhesion of the strong circular ligament which goes thence to the first vertebra.

One end of each lateral or moderator ligament of the head, is fixed to a rough surface at the forepart of each condyle, and the perpendicular one is connected to a rough part of the edge of the great hole between the two condyles.

Immediately before the condyles, two little depressions are made in the external suface of the cuneiform process, for the insertion of the recti anteriores minores muscles, which are unjustly ascribed to Cowper: And still further forward, nearer the sphenoid bone, are two other such depressions, for the reception of the recti anteriores majores. The muscles which pull the head backwards, are stronger than those are which bend it forwards; and acquire greater force by the long lever they act with, than the latter which are inserted so near the condyles. This great force in the extensor muscles is altogether necessary, that they might not only keep the head from falling forward in an erect posture, but that they might support it when we bow forward in the most necessary offices of social life, when the weight of the head comes to act at right angles on the ver-

tebræ of the neck, and obtains a long lever to act with.

On the inner surface of the os occipitis we see two ridges; one standing perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the falx is fixed, is hollowed in the middle, or often on one side, for the reception of the superior longitudinal sinus, and the lower part of it has the small or third process of the dura mater fastened to it, and is sometimes hollowed by the occipital sinus. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the dura mater; the fossa in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and therefore is larger than the left one *. Round the middle of the cross there are four large depressions separated by its limbs; the two upper ones being formed by the back-part of the brain, and the two lower ones by the cerebellum.

Farther forward than the last-mentioned depressions, is the lower part of the fossa for the lateral sinus on each side. The inner surface of the cuneiform apophyse is made concave for the reception of the medulla oblongata, and of the basilar artery. A furrow is made on each side, near the edges of this process, by a sinus of the

* Morgagn. Advers. Anat. 6. Animad. 1.

dura mater, which empties itself into the lateral sinus*.

The holes of this bone are commonly five proper, and two common to it and to the temporal bones. The first of the proper holes, called *foramen magnum*† from its size, is immediately behind the wedge-like process, and allows a passage to the medulla oblongata, nervi accessorii, to the vertebral arteries, and sometimes to the vertebral veins. At each side of this great hole, near its fore-part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite again into one that opens externally; through these the ninth pair of nerves go out of the skull. The fourth and fifth holes pierce from behind the condyle of each side into the fossæ of the lateral sinuses; they serve for the passage of the cervical veins to these sinuses. Often one of these holes is wanting, sometimes both, when the veins pass through the great foramen. Besides these five, we frequently meet with other holes near the edges of this bone, for the transmission of veins; but their number and diameter are very uncertain.

The two common foramina are the large irregular holes, one in each side, between the sides of the cuneiform process, and the edges of the petrous bones. In a recent subject, a strong membrane runs cross from one side to the other of each

* Albin. de Ossib. § 65.

† Rachitidis, Medullæ spinalis.

of these holes; in some heads I have seen this membrane ossified, or a bony partition dividing each hole; and, in the greater number of adult skulls, there is a small sharp-pointed process stands out from the os petrosum, and a more obtuse rising in the occipital bone, between which the partition is stretched. Behind this partition, where the largest space is left, the lateral sinus has its passage; and before it the eighth pair of nerves and accessorius make their exit out of the skull; and some authors say, an artery passes through this hole, to be bestowed on the dura mater.

The occipital bone is among the thickest of the cranium, though unequally so; for it is stronger above, where it has no other defence than the common teguments, than it is below, where, being pressed by the lobes of the brain and cerebellum on one side, and by the action of the muscles on the other, it is so very thin, as to be diaphanous in many skulls: but then these muscles ward off injuries, and the ridges and spines, which are frequent here, make it sufficiently strong to resist ordinary forces. The tables and diploe are tolerably distinct in this bone, except where it is so thin as to become diaphanous.

The occipital bone is joined above to the ossa parietalia and triquetra when present, at the lambdoid suture; laterally to the temporal bones, by the additamenta of the lambdoid suture; below to the sphenoid bone, by the end of its cunei-

form process*, in the same way that epiphyses and their bones are joined: for, in children, a ligamentous cartilage is interposed between the occipital and sphenoid bones, which gradually turns thinner, as each of the bones advances, till their fibres at last run into each other; and, about sixteen or eighteen years of age, the union of these two bones becomes so intimate, that a separation cannot be made without violence. The os occipitis is joined by a double articulation to the first vertebra of the neck, each condyle being received into a superior oblique process of that vertebra.

In an infant born at the full time, this bone is divided, by unossified cartilages, into four parts. The first of these is larger than the other three, is of a triangular shape, and constitutes all the part of the bone above the great foramen. Generally fissures appear in the upper part and sides of this triangular bone, when all the cartilage is separated by maceration; and sometimes little distinct bones are seen towards the edges of it. The second and third pieces of this bone are exactly alike, and situated on each side of the great foramen; from which very near the whole condyles are produced; and they are extended forwards almost to the fore-part of the hole for the ninth pair of nerves. The

* In the adult, the occipital and sphenoid bones are firmly fixed to each other; and hence SOEMMERING has described them under the name of Os spheno-occipitale.

fourth piece is the cuneiform process, which forms a small share of the great hole, and of these for the ninth pair of nerves and of the condyles: betwixt it and the sphenoid bone, a cartilage is interposed.

Of the eight bones which belong to the cranium, there are only two which are not yet described, viz. the *ethmoid* and *sphenoid*. These we already mentioned, in complaisance to the generality of writers on this subject, as bones common to the cranium and face, because they enter into the composition of both: But the same reason might equally be used for calling the frontal-bone a common one too.

Os Ethmoides.

The Os ETHMOIDES *, or the sieve-like bone, has got its name from the great number of small holes with which that part of it first taken notice of, is pierced. When this bone is entire, the figure of it is not easily described; but, by a detail of its several parts, some idea may be afforded of the whole; and therefore I shall distinguish it into the *cribriform lamella*, with its process, the *nasal lamella*, *cellulæ*, and *ossa spongiosa*.

The thin horizontal lamella, is all (except its back-part) pierced obliquely by a great number

* Cribriforme, σπογγοειδὴς, spongiforme, cristatum.

of small holes, through which the filaments of the olfactory nerves pass *. In a recent subject, these

* Vid. Monro on the Nervous System.

Scarpa also has very minutely described the structure of the horizontal cribriform plate: "Siquidem iteratæ observationes me docuerunt naturam certum quemdam ordinem, institutumque servare in pertundendis amplioribus laminæ cribrosæ foraminibus a parte cranii, nullam vero, aut non satis definiendam normam sequi in ea laminæ ipsius facie, quæ naribus est obversa. Scilicet in priori, qua nempe cranii cavitatem spectat, majora et ampliora foramina disposita sunt in series omnino duas secundum laminæ cribrosæ longitudinem ductas, quarum altera et interior processus cristægalli radicem legit, altera vero, eaque exterior secundum latus ejusdem laminæ externum insculpta est. Series interior modo sex, modo octo majoribus foraminibus constat, desinitque anterius in oblongam rimam intra summam, et priorem narium caveam hiantem. Series altera, seu exterior, totidem, ut plurimum, ac prior foramina exhibet, quorum ordo in anteriori laminæ cribrosæ sede sulco osseo excipitur, per quem in recentibus subjectis nervus a pari quinto ad nares trajicitur. Spatium quod duæ modo memoratæ foraminum series intercipiunt, sub initio, et quidem a parte ossis sphenoidei, nullis propemodum, aut raris quibusdam, iisque exiguis ostiolis pertusum albæ teniolæ speciem in exsiccatis capitibus refert. Quo magis vero ad anteriora progreditur, tum maxime prope priorem laminæ ethmoideæ sedem, crebra inter duos ordines majorum foraminum occurrunt ostiola, quibus, nulla inter se figuræ, aut amplitudinis servata ratione, lamina cribrosa tota pertusa est. Evenit interdum alterutram majorum foraminum seriem ita inflexam esse, ut unum, aut alterum ex majoribus ostiis mediam laminæ cribrosæ sedem teneat. Sed id ipsum minime obstat, quin vel inter varietates, quæ aliquando occurrunt, duplicem perpetuo majorum foraminum ordinem, interiorem unum, exteriorem alterum a cæteris extra ordinem insculptis ostiolis distinguamus.

holes are so closely lined by the dura mater, that they are much less conspicuous than in the skeleton.

From the middle of the internal side of this plate, a thick process rises upwards, and, being highest at the fore-part, gradually becomes lower, as it is extended backwards. From some resemblance which this process was imagined to have to a cock's comb, it has been called *crista galli* *; the falx is connected to its ridge, and to the unperforated part of the cribriform plate. When the crista is broken, its base is sometimes found to be hollow, with its cavity opening into the nose †.

Immediately before the highest part of this process, is the blind hole of the frontal-bone, which, as was formerly remarked, is often in a good measure formed by a notch in the fore-part of the root of the crista.

Porro canaliculi, de quibus sermo est, quoniam non omnes in suprema narium cavitate desinunt, neque eadem incedunt directione, neque demum per eamdem narium regionem feruntur: ita opportunum, et naturæ consonum videtur, tum singulos, tum universos in tres classes distinguere; nimirum in eos, qui ab interna laminæ ethmoideæ facie initio ducto, laminæ ejusdem crassitudinem longitudine vix excedunt; in eos qui ulterius elongati per septum narium descendunt; in eos denique qui per turbinatorum ossium superiorum lamellas feruntur ‡."

* Verruca prædura, septum ossis spongiosi.

† Palfyn. Anat. chir. tr. 4. chap. 15.

‡ Vid. his Annot. Annat. lib. 2. de Organ Olfact. Tinan. Reg. 1785.

From the middle of the outer surface of the cribriform lamella, a thin solid plate is extended downwards and forwards, having the same common base with the crista galli. Generally it is not exactly perpendicular, but is inclined to one side or other, and therefore divides the cavity of the nose unequally. Its inclination to one side, and flexure in the middle, is sometimes so great, that it fills up a large share of one of the nostrils, and has been mistaken for a polypus there.

It is thin at its rise, and rather still thinner in its middle; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the nose might be firmer.

At a little distance from each side of this external process, a cellular and spongy bony substance depends from the cribriform plate. The number and figure of the cells in this irregular process of each side, are very uncertain, and not to be represented in words; only the cells open into each other, and into the cavity of the nose: The uppermost, which are below the aperture of the frontal sinuses, are formed like funnels.

The outer surface of these cells is smooth and plain, where this bone assists in composing the orbit; at which place, on each side, it has got the name of *os planum;* on the upper edge of which,

a small notch or two may sometimes be observed, which go to the formation of the internal orbitar holes, as was remarked in the description of the frontal-bone.

Below the cells of each side, a thin plate is extended inwards, and then bending down, it becomes thick and of a spongy texture. This spongy part is triangular, with a straight upper edge placed horizontally, an anterior one slanting from above, downwards and forwards, and with a pendulous convex one below. The upper and lower edges terminate in a sharp point behind.

The side of this pendulous spongy part next to the septum narium is convex, and its external side is concave. These two processes of the ethmoid bone, have got the name of *ossa spongiosa*, or *turbinata superiora*, from their substance, figure, and situation.

The prominencies, and cavities of this ethmoid bone, are covered with a continuation of the membrane of the nostrils, in a recent subject.

Its horizontal cribriform plate is lodged between the orbitar processes of the frontal-bone, to which it is joined at the ethmoid suture, except at the back-part where it is connected with the cuneiform-bone, by a suture common to both these bones, though it is generally esteemed part of the sphenoidal.

Where the ossa plana are contiguous to the fron-

tal-bone within the orbit, their conjunction is reckoned part of the transverse suture.

Farther forward than the ossa plana, the cells are covered by the ossa unguis, which are not only contiguous to these cells, but cannot be separated from them, without breaking the bony substance; and therefore, in justice, those bones ought to be demonstrated as part of the ethmoid bone.

Below the ossa unguis and plana, these cells and ossa spongiosa are overlopped by the maxillary bones.

The cellular part of each palate-bone is contiguous to each os planum, and cells backwards. The lower edge of the nasal perpendicular plate is received into the furrow of the vomer.

Its posterior edge is joined to the fore-part of the processus azygos of the sphenoid bone. Its upper edge joins the nasal process of the frontal and nasal bones, and its anterior one is connected to the middle cartilage of the nose.

This bone sustains the anterior lobes of the brain; gives passage to the olfactory nerves, and attachment to the falx; enlarges the organ of smelling, by allowing the membrane of the nose a great extent; straitens the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form part of the or-

bit of the eyes and septum narium; while all its parts are so light as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface, without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

On account of the structure of this bone, an ozæna is difficult to cure; and from violent scurvies, or the lues venerea, the fabric of the nose, the eyes, and life itself are in danger. The situation of the nasal plate may shew us, how dangerous a fracture of the bones of the nose may be, when made by a force applied to their middle fore-part, of a person in whom this nasal plate is perpendicular. *.

The ethmoid bone of ripe children is divided into two, by a perpendicular cartilage, which, when ossified, is the crista galli, and nasal plate.

Os Sphenoides.

The Os SPHENOIDES †, or wedge-like bone, so

* Vid. also SCHNEIDER de osse cribriformi.

SANTORINI's obs. anat. and the 6th of MORGAGNI adversar. anatomica.

HALLER Tab. Narium internarum.

BLUMENBACH de sinibus frontalibus.

† Cuneiforme, πολύμορφον, multiforme, paxillum, cribratum, palati, colatorii, cavilla, basilare.

called because of its situation in the middle of the bones of the cranium and face, is of such an irregular figure, that I know not any thing, to which it may be likened, unless perhaps it bear some faint resemblance to a bat with its wings extended.

When we view the external surface of the os sphenoides, two or three remarkable processes from each side of it may be observed, which are all of them again subdivided. The first pair is the two large lateral processes or wings; the upper part of each of which is called the temporal process, because they join with the temporal bones in forming the temples, and the seat of a share of the temporal muscles. That part of the wings which juts out towards the inside, somewhat lower than the temporal apophyses, and is smooth and hollowed, where it makes up part of the orbit, is thence named *orbitar process.* Behind the edge, separating these two processes, there is often a small groove, made by a branch of the superior maxillary nerve, in its passage to the temporal muscle. The lowest and back-part of each wing, which runs out sharp to meet the ossa petrosa, has been styled the *spinous process:* From near the point of which a sharp-pointed process is frequently produced downwards, which some call *styliform,* and affords origin to the ptery-staphylinus externus muscle. From this styloid process a very small groove is extended along the edge of the bone to the hollow at the root of the

internal plate of the following process, which forms part of the eustachian tube *. The second pair of external processes of the cuneiform bone is the two which stand out almost perpendicular to the base of the skull. Each of them has two plates, and a middle fossa facing backwards, and should, to carry on our comparison, be likened to the bat's legs, but are commonly said to resemble the wings of that creature; and therefore are named *pterygoid* or *aliform* † processes. The external plates are broadest, and the internal are longest. From each side of the external plates the pterygoid muscles take their rise. At the root of each internal plate, a small hollow may be remarked, where the muscle ptery-staphylinus internus, or circumflexus palati rises, and some share of the cartilaginous end of the eustachian tube rests; and, at the lower end of the same plate, is a hook-like rising or process, round which the tendon of the last-named muscle plays, as on a pulley. From the edge of the external plates there are some small projections of bone. There is also a little triangular thin process, which comes from each side of the body of the sphenoid bone, where the pterygoid processes are rising from it, and are extended over the lower part

* Winslow, Exposition Anatomique du corps humain, Traité des os secs, § 233.

† Naviculares.

of the aperture of the sinus as far as to join the ethmoid bone, while their body hangs down into the nares *. Besides these pairs of processes, there is a sharp ridge which stands out from the middle of its base, hence called *processus azygos*. The lower part of this process, where it is received into the vomer, is thick, and often not quite perpendicular, but inclining more to one side than the other. The fore-part of this process, where it joins the nasal plate of the os ethmoides, is thin and straight. These two parts have been described as two distinct processes by some.

The depressions, sinuosities and fossæ, on the external surface of this sphenoid bone, are two on the temporal apophyses where the crotaphite muscles lodge: Two on the orbitar processes, to make way for the globes of the eyes: Two between the temporal and spinous processes, for receiving the temporal bones: Two between the plates of the pterygoid processes, where the musculi pterygoidei interni and ptery staphylini interni are placed: Two between the pterygoid and orbitar processes, for forming the holes, common to this, and to the cheek and maxillary bones: Two on the lower ends of the aliform processes, which the palate bones enter into: Two at the roots of the

* Albin. Tab. Oss. v, Fig. 2. 6. A. A. Bertin. Mem de l'Acad. des Sciences, 1744. Sue, planche viii. Fig. 2, 3, 4, 5, 6.

temporal and pterygoid processes, where the largest share of the external pterygoid muscles have their rise : Two at the sides of the processus azygos, for forming part of the nose, &c.

What I described under the name of temporal and spinous processes on the outside of the skull, are likewise seen on its inside, where they are concave, for receiving part of the brain ; and commonly three apophyses on the internal surface of the sphenoid bone are only mentioned. Two rising broad from the fore-part of its body, become smaller as they are extended obliquely backwards. The third, standing on a long transverse base, near the back-part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*, from some resemblance which they were thought to have to the supporters of a bed. Sometimes one or both the anterior clinoid processes are joined to the sides of the posterior one, or to the body of the bone itself. From the roots of the interior clinoid processes the bone is extended on each side outwards and forwards, till it ends in sharp points, named the *transverse spinous process*. Between, but a little farther back than the two anterior clinoid processes, we see a protuberance considerably smaller than the posterior clinoid process, but of its shape. Another process from between the transverse processes, often forces itself forwards into the os ethmoides.

Within the skull, there are two sinuosities in the internal part of each wing of the sphenoid bone, for receiving the middle part of the brain. One between the transverse spinous processes, for lodging the part of the brain where the crura medullæ oblongatæ are. Immediately before the third or middle clinoid process, a single pit generally may be remarked, from which a fossa goes out on each side to the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the fossæ these nerves are lodged, as they run divided within the skull. Between that third protuberance and the posterior clinoid process, the large pit for the glandula pituitaria may be remarked. This cavity, because of its resemblance to a turkish saddle, is always described under the name of *sella turcica*, or *ephippium*. On the sides of the posterior clinoid process a fossa may be remarked, that stretches upwards; then is continued forwards along the sides of the sella turcica, near to the anterior clinoid processes, where a pit on each side is made. These fossæ point out the course of the two internal carotid arteries after they have entered the skull. Besides all these, several other fossæ may be observed, leading to the several holes, and imprinted by the nerves and bloodvessels.

The holes on each side of the os sphenoides are six proper, and three common. The first is the round one immediately below the anterior clinoid processes, for the passage of the optic nerve, and

of the branch of the internal carotid artery that is sent to the eye. The second is the foramen lacerum, or large slit between the transverse spinous and orbitar processes: the interior end of which slit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the os frontis; and therefore this might be reckoned among the common foramina. Through it the third, fourth. the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters its end, to be distributed to the dura mater *, and a vein, some call it the *venous duct*, or, *Nuck's aqueduct*, returns through it to the cavernous sinus. The third hole, situated a little behind the one just now described, is called *rotundum*, from its shape. It allows passage to the second branch of the fifth pair of nerves, or superior maxillary nerve. The fourth is the foramen ovale, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior maxillary nerve, goes out; and sometimes a vein from the dura mater passes out here †. Very near the point of the spinous process is the fifth hole of this bone: it is small and round, for

* Winslow, Exposition Anatomique du corps humain, Traité des Artères, § 60. & de la Tête, § 26.

† Ingrass. Commentar. in Galen, de Ossib. lib. 1. comment. 8.

a passage to the largest artery of the dura mater, which often is accompanied with a vein. The sixth proper hole * cannot be well seen, till the cuneiform bone is separated from all the other bones of the cranium; for one end of it is hid by a small protuberance of the internal plate of the pterygoid process, and by the point of the processus petrosus of the temporal bone. Its canal is extended above the inner plate of the pterygoid process; and where it opens into the cavity of the nose, it is concealed by the thin laminous part of the palate bone. Through it a considerable branch of the second branch of the fifth pair of nerves is reflected. Often in the middle of the sella turcica a small hole or two pierce as far as the cellular substance of the bone; and sometimes at the sides of this sella, one or more small holes penetrate into the sphenoidal sinuses. These observations afforded some anatomists † an argument of weight in their days in defence of GALEN ‡, who asserted the descent of the pituita that way into the sinuses below.

The first of the common holes is that unequal fissure at the side of the sella turcica, between

* VESAL. Anat. lib. 1. cap. 12. EUSTACH. Tab. 46. Fig. 13. & 16. VIDUS VIDIUS, Anat. lib. 2. cap. 2. Explicat. Tab. 3. & Tab. 5. Fig. 8. 9. 10. lit. O.

† JAC. SYLV. Calumniæ secundæ amolitio. LAURENT. Hist. Anat. lib. 2. quæst. 11.

‡ GALEN. De usu Part. lib. 9. cap. 1.

the extreme point of the os petrosum and the spinous process of the cuneiform bone. This hole only appears after the bones are boiled; for, in a recent subject its back-part is covered by a thin bony plate that lies over the internal carotid artery, and farther forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the eustachian tube is placed: It was by this passage that the ancients believed the slimy matter was conveyed from the emunctory of the brain, the glandula pituitaria, to the fauces. The second common hole is the large discontinuation of the external side of the orbit, left between the orbitar processes of the cuneiform bone, the os maxillare, malæ, and palati. In this large hole the fat for lubricating the globe of the eye and temporal muscle is lodged, and branches of the superior maxillary nerve, with small arteries from the carotid and veins pass. The third hole is formed between the base of this bone and the root of the orbitar process of the palate-bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, are allowed a passage to the nostrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate bone, being entirely formed out of its substance.

Under the sella turcica, and some way farther forward, but within the substance of the sphenoid bone, are two sinuses separated by a bony plate. Each of them is lined with a membrane, and opens

into the upper and back-part of each nostril by a round hole, which is at their upper fore-part. This hole is not formed only by the os sphenoides, which has an aperture near as large as any transverse section of the sinus, but also by the palate bones which are applied to the fore-part of these sinuses, and close them up, that hole only excepted, which was already mentioned. Frequently the two sinuses are of unequal dimensions, and sometimes there is only one large cavity, with an opening into one nostril. These cavities are likewise said * to be extended sometimes as far back as the great foramen of the occipital bone. In other subjects they are not to be found, when the bone is composed of large cells †. Some ‡ mention a cavity within the partition of the sinuses; but it is small. The sphenoidal sinuses serve the same uses as the frontal do.

As this bone is extremely ragged and unequal, so its substance is of very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back-part surpasses the greatest share of the cranium in thickness.

The os sphenoides is joined by its wings, to the parietal bones above, to the os frontis and ossa malarum before, to the temporal bones behind;

* Albin. de Ossib. § 39.

† Vesal. lib. 1. cap. 6.

‡ Id. Ibid.

by the fore-part of its body and spinous processes, to the frontal and ethmoid bones; by its back-part, behind the two sinuses, to the occipital, where it looks like a bone with the epiphyses taken off, and, as was formerly observed in the description of the occipital bone, it cannot be separated without violence in adults; to the palate bones, by the ends of the pterygoid processes, and still more by the fore-part of the internal plates of the pterygoid processes, and of the sinuses; to the maxillary bones, by the fore-part of the external pterygoid plates; to the vomer and nasal plate of the os ethmoides, by the processus azygos. All these conjunctions, except the last, which is a schindylesis, are said to be by the suture proper to this bone, though it is at first sight evident, that several other sutures, as the transverse, ethmoidal, &c. are confounded with it.

The sphenoid bone is almost complete in a fœtus of nine months; only the great alæ separate after maceration from the body of the bone. The processus azygos is very large and hollow; the thin triangular processes are not ossified; and the sinuses do not appear.

THE FACE.

The FACE is the irregular pile of bones, composing the fore and under part of the head, which

is divided, by authors, into the upper and lower maxillæ or jaws *.

* The bones of the face are considerably larger in the adult, in proportion to those of the cranium, than in the infant.

In some Negroes, the upper and under jaws are much more prominent than in the European *.

The bones of the jaws of some Negroes are more prominent than those of others, and the jaws of most of the simia tribe are still more prominent than those of the Negro.

Upon the above fact, Dr CAMPER has grounded his method of distinguishing national peculiarities as to the form of skulls, and has endeavoured to establish a regular gradation between them.

But the above method of estimating the differences in skulls of different nations is imperfect; for it points out only those distinctions which result from the degrees of prominence of the jaws; and it is liable also to insuperable objections; for there are skulls of different nations which have the same prominence of the jaws, but which are very different in other respects, and, on the other hand, there are also crania which agree in most respects as to form, but the jaws of such cranium are widely different as to the degree of prominence, and of course as to the direction of the facial line.

Beside, there are many of the nations inhabiting different parts of Africa, *whose head in form resembles that of the European;* for instance, the skull of the Hottentot (which now lies before me) differs from that of the European only as to the small size of the orbits. The Caffre, I have been informed, exactly resembles the European as to the form of the head; and Dr WINTERBOTTOM, in his account of Sierra Leone, has observed, "the "sloping contracted fore-head, small eyes, depressed nose, "and projecting jaw, with which the African is usually delinea-"ted, are by no means constant traits."

* Vid. Plates, XIX & XX.

The superior maxilla *, is the common designation given to the upper immoveable share of the face. The upper jaw is bounded above by the transverse suture, behind by the fore-part of the sphenoid bone, and below by the mouth.

The upper jaw consists of six bones on each side, of a thirteenth bone which has no fellow, placed in the middle, and of sixteen teeth. The thirteen bones are, two *ossa nasi*, two *ossa unguis*, two *ossa malarum*, two *ossa maxillaria*, two *ossa palati*, two *ossa spongiosa inferiora*, and the *vomer*.

The ossa nasi are placed at the upper part of the nose; the ossa unguis are at the internal canthi of the orbits; ossa malarum form the prominence of the cheeks; ossa maxillaria form the side of the nose, with the whole lower and fore-part of the upper jaw, and the greatest share of the roof of the mouth; ossa palati are situated at the back-part of the palate, nostrils, and orbit; ossa spongiosa are seen in the lower part of the nares; and the vomer helps to separate these two cavities.

The bones of the upper jaw are connected to each other by gomphosis and fifteen sutures.

The first is the *anterior nasal* †, which is straight, and placed longitudinally in the middle fore-part of the nose.

* Σιαγων, γινος. Mandibula.

† Nasalis recta.

The second and third are the *lateral nasal* *, which are at each side of the nose, and almost parallel to the first suture.

Each of the two *lacrymal* is almost semicircular, and is placed round the lacrymal groove.

The sixth and seventh are the *internal orbitar;* each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two *external orbitars* are continued, each from the end of the internal orbitar, to the under and fore part of the cheek.

The tenth is the *mystachial*, which reaches only from the lower part of the septum narium, to between the two middle dentes incisores.

The *longitudiual palate* † suture stretches from the middle of the foremost teeth through the middle of all the palate.

The *transverse palate* one ‡ runs across the palate, nearer the back than the fore-part of it.

Each of the two *palato-maxillary* is at the back-part of the side of each nostril.

The fifteenth is the *spinous*, which is in the middle of the lower part of the nostrils. This may, perhaps, be rather thought a double schindylesis.

* Nasalis obliqua.

† Laquearis, palataria recta.

‡ Arcuata, palatina postica.

The connexion of the ossa spongiosa to the side of each nostril, is so much by a membrane in young subjects, by a sort of hook, and afterwards by concretion or union of substance in adults, that I did not know well how to rank it: But if any chuses to call it a suture, the addition of two transverse nasal sutures may be made to those above named.

These sutures of the face, (formerly called *harmoniæ*), have not such conspicuous indentations as those of the skull; the bones not having substance enough for forming large indentations, and there being less necessity for security against external injuries, or any internal protruding force, than in the cranium. These sutures often disappear in old people, by the bones running into each other; which can do little prejudice, because the principal use of the bones being so numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of the conjunction of these bones, that they can have no motion, except in common with the cranium.

Ossa Nasi.

The Ossa Nasi, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than their middle,

and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connexion with the frontal bone might be stronger. These bones are convex externally, and thereby better resist any violence from without; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal, and is stretched outwards and backwards, to join the cartilages of the nostrils. Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger; and a small rising may be remarked on their inner edge, where they are sustained by the septum narium. Their posterior side, at its upper half, has externally a depression, where it is overlopped some way by the maxillary bones, while its lower half covers these bones: By which contrivance, they do not yield easily to pressure applied to their fore-part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate, for the transmission of small veins: sometimes the holes go no farther than the cancelli of the bones.

The nasal bones are firm and solid, with very few cells or cancelli in them; the thin substance, of which they consist, not requiring much marrow.

They are joined above to the frontal bone, by the middle of the transverse suture; behind, to the maxillary bones, by the lateral nasal sutures; below, to the cartilages of the nose; before, to one another, by the anterior nasal suture; internally, to the septum narium.

These bones serve to cover and defend the root of the nose.

In an infant, the nasal bones are proportionally shorter, and thinner at their upper part, than in an adult, and porous on the internal surface.

Ossa Unguis.

The OSSA UNGUIS, or LACRYMALIA, are so named, because their figure and magnitude are something near to those of a nail of one's finger, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge. The depression behind forms a small share of the orbit for the eye-ball to move on, and the one before is a deep perpendicular canal, or fossa, larger above than below, containing part of the lacrymal *sac* and *duct*. This is the part that ought to be pierced in the operation for the *fistula lacrymalis**. This fossa of the bone is cribriform, or has a great

* See an account of the disease called *Fistula lacrymalis*, in the Works by Dr MONRO *primus*, p. 522.

number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes, might prevent a separation of the membrane, and secure the bone in its natural situation. The ridge between these two cavities of the os unguis, is the proper boundary of the orbit at its internal canthus; and beyond which surgeons should not proceed backwards in performing operations here. The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the os unguis is as thin as paper, and very brittle; it is easily pierced in living subjects.

Each of these bones is joined, above, to the frontal bone, by part of the transverse suture; behind, to the os planum of the ethmoid bone, by the same suture; before, and below, to the maxillary bone, by the lacrymal suture. Internally, the ossa unguis cover some of the sinus ethmoidales; nay, are really continuous with the bony lamellæ which make up the sides of these cells; so that they are as much part of the ethmoid bone, as the ossa plana.

These unguiform bones compose the anterior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the ethmoid cells. Their situation and tender substance, make a rash operator in danger of destroying a considerable share of the organ of smelling, when he is performing the operation of the fistula lacrymalis;

but when these bones are hurt, they cast off without much difficulty, and consequently the wound is soon cured, unless there is a predisposition in the bones to caries.

These bones are fully formed in a new-born child.

Ossa Malarum.

The OSSA MALARUM * are prominent square bones, which form the cheek on each side †. Before, their surface is convex and smooth; backward, it is unequal and concave, for lodging part of the temporal muscles.

The four angles of each of these bones have been reckoned processes by some. The one at the external canthus of the orbit, called the *superior orbitar* process, is the longest and thickest. The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbitar* process. The third, placed near the lower part of the cheek, and thence called *maxillary*, is the shortest, and nearest to a right angle. The fourth, which is called *zygomatic*, because it is extended backwards to the zygoma of the temporal bone, ends in a point, and has one

* Jugalia vel zygomatica, hypopia, subocularia.

† These bones are larger in the Scotch than the English: they are small in the Hindoo; but remarkably large in the skulls of the Turk, New Hollander, African, and Eskimaux, vid. plates xix, xx, & xxi.

side straight, and the other sloping. Between the two orbitar angles, there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one-third of that cavity; and hence it may be called the *internal orbitar* process. From the lower edge of each of the ossa malarum, which is between the maxillary and zygomatic processes, the masseter muscle takes its origin; and from the exterior part of the zygomatic process, the musculus distortor oris rises; in both which places the surface of the bone is rough.

On the external surface of each cheek-bone, one or more small holes are commonly found, for the transmission of small nerves or bloodvessels from, and sometimes into the orbit. On the internal surface are the holes for the passage of the nutritious vessels of these bones. A notch on the outside of the internal orbitar process of each of these bones, assists to form the great slit common to this bone, and to the sphenoid, maxillary, and palate bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid, with some cancelli.

Each of the ossa malarum is joined, by its superior and internal orbitar processes, to the os frontis, and to the orbitar process of the sphenoid bone, by the transverse suture. By the edge between the internal and inferior orbitar processes,

to the maxillary bone, by the internal orbitar suture; by the side between the maxillary and inferior orbitar process, again to the maxillary bone, by the external orbitar suture; by the zygomatic process to the os temporum, by the zygomatic suture.

The cheek-bones are entire, and fully ossified in all their parts in infants.

Ossa Maxillaria Superiora.

The OSSA MAXILLARIA SUPERIORA, are the largest bones, and constitute the far greater part of the upper jaw, which has appropriated the name of *maxillaria* to them. The figure of one of them, or of the two when joined, is so irregular, that words can scarce give an idea of it.

The processes of each os maxillare may be reckoned seven. The first is the long nasal one at its upper and fore-part, which is broad below, and turns smaller, as it rises upwards to make the side of the nose. At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the os spongiosum inferius. The second is produced backwards and outwards, from the root of the nasal process, to form the lower side of the orbit; and therefore may be called *orbitar*. The edge of this orbitar process, and the ridge of the nasal one, which is continued from it, make a considerable portion of the external circumference

of the orbit. From the proper orbitar process, a very rough triangular surface is extended downwards and outwards, to be connected to the cheek-bone; and therefore may be called the *malar* process, from the lowest protuberant part of which some share of the masseter muscle takes its rise. Behind the orbitar process, a large tuberosity, or bulge of the bone appears, which is esteemed the fourth process. On the internal part of this we often meet with a ridge, almost of the same height with that in the nasal process, which runs transversely, and is covered by a similar ridge of the palate-bone, on which the back-part of the upper edge of the os spongiosum inferius rests. The convex back-part of this tuberosity is rough for the origin of part of the external pterygoid muscle *, and more internally is scabrous, where the palate and sphenoid bones are joined to it. That spongy protuberance † at the lower circumference of this bone, where the sockets for the teeth are formed, is reckoned the fifth. The sixth is the horizontal plate, which forms the greater part of the base of the nostrils, and roof of the mouth; its upper surface, which belongs to the nostrils, is very smooth, but the other below is arched and rough, for the stronger adhesion of the membrane of the mouth, which is stretched upon it, and in chewing, speaking, &c. might

* Albin. de Ossib. § 79.

† φάτνια.

otherwise be liable to be separated. The seventh rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each maxillary bone are, 1. A sinuosity behind the orbitar process, made by the temporal muscle. 2. A pit immediately before the same process, where the origin of the musculus elevator labiorum communis, and elevator labii superioris, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the palate. 4. The semicircular great notch, or entry to the lower part of the nostrils, betwixt the root of the nasal process and spine of the palate plate. Below this, the fore-part of the bone is flatted, or sometimes hollowed by the musculus depressor labii superioris. 5. Sockets for the teeth *: The number of these sockets is uncertain; for the same number of teeth is not in all people, and the four backmost teeth of each side of each jaw vary greatly in their number of roots; and when the teeth of a living person fall out, or are taken away, the sockets fill up with an osseous net-work, which becomes solid afterwards. 6. The lacrymal fossa in the nasal process, which assists the os unguis to form a passage for the lacrymal duct. This part of the bone forming this fossa is so firm and strong that a surgeon scarce *can*

* Βόθρια, ὀλμίσκοι, Alveoli, fossulæ, mortariola, frena, loculi, cavæ, pralsepiola, loculamenta.

perforate it. Immediately on the outside of this, there is a small depression, from which the inferior or lesser oblique muscle of the eye has its origin *. 7. The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole; in this a branch of the superior maxillary nerve passes.

Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.

Immediately above the transverse ridge in the nasal process, a small hollow is formed by the os spongiosum. In some subjects, the nasal process, has a small round pit above the lacrymal duct, where the little tendon or ligament of the orbicular muscle of the eye-lids is inserted. It is this tendon, and not the tendon of the larger oblique muscle of the eye, which there is some hazard of cutting in the operation of the fistula lacrymalis.

The holes of this bone are two proper and two common, which are always to be found, besides several others, whose magnitude, number, &c. are uncertain. The first of the proper is the external orbitar, immediately below the orbit, by which the infra-orbitar branch of the second branch of the fifth pair of nerves, and a small artery come out, after having passed in the canal, at the bottom of the orbit, described numb. 7. of the depressions. This hole is often double, and that when the nerve has happened to split

* Winslow, Exposition Anatomique des Os Secs, § 276.

before it has escaped from the bone. The second is the foramen incisivum, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the maxillary bones when they are joined; but, as it ascends, soon divides into two, three, or sometimes more holes; some of which open into each nostril. Through them small arteries and veins, and a twig of the second branch of the fifth pair of nerves pass, and make a communication between or join the lining coats of the nose and mouth. In some subjects, Steno's duct may be traced some way on the side of these passages next to the nose, and small orifices may be observed opening into the mouth.

The first common hole is that which appears at the inner side of the back-part of the tuberosity and of the sockets of the teeth, and is formed by a fossa in this bone, and a corresponding one in the os palati: Through it a nerve, which is a branch of the second branch of the fifth pair, runs to the palate. The other common hole is the great slit in the outside of the orbit described already, as the second common hole of the sphenoid bone.

On the nasal process often holes may be observed for the passage of vessels to the substance of the bones; and, at the back-part of each tuberosity, several foramina are placed, for the transmission of nerves to the cavity within: But these are uncertain.

The body of the maxillary bone is hollow and leaves a large sinus, akin to the frontal and sphe-

noid, which is commonly, but unjustly called *antrum highmorianum* *.

When the os maxillare is single or separated from all the other bones of a skeleton, its antrum appears to have a large aperture into the nostrils; but, in a recent subject, it is so covered at its back-part by the palate bone; in the middle, by the os spongiosum inferius; before, by a strong membrane, that one, or sometimes *two holes scarce larger than a crow-quill, are only left at the upper part;* which after a short winding progress, open into the nostrils between the two ossa spongiosa. At the bottom of this cavity, we may often observe some protuberances, in which the small points of the roots of the teeth are contained †. This cavern, and the sockets of the teeth are often divided by the interposition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the antrum, or to be broke in drawing a tooth ‡. The symptoms of a collection of matter here naturally lead us to the practice of pulling out the teeth, and piercing through this plate into the antrum, to procure an evacuation of the collected matter; by which considerable service is frequently done ‖.

* Genæ.

† Highmore, Disquis. Anat. lib. 3. part. 2. cap. 1.

‡ Highmore, Ibid.

‖ Cowper, in Drake's Anthropol. Book 3. chap. 10. Medical Essays and Observ. vol. v. Art. 30.

The maxillary sinuses have the same uses as the frontal and sphenoidal; and the situation of the sinuses is such, that the liquor distilling from them, from the cells of the ethmoid and palate-bones, and from the lacrymal ducts, may always moisten all the parts of the membrane of the nares in the different situations which the head is in.

The membrane, which lines the frontal, sphenoidal, and maxillary sinuses, is a continuation of the one which covers the bones within the nose; but much thinner, and it has but few blood-vessels.

The substance of the ossa maxillaria is compact and firm, except at the inferior process, in which the teeth are lodged, where it is very spongy.

The maxillary bones are joined above by the upper ends of their nasal processes to the os frontis, by the transverse suture; at the sides of these processes, to the ossa unguis, by the lacrymal sutures; to the nasal bones, by the lateral nasal sutures; by their orbitar processes, to the cheek-bones, by the external orbitar sutures; by the internal sides of the internal orbitar processes, to the ossa plana, by part of the ethmoidal suture; by the back-part of the tuberosities, to the palate-bones, by the suturæ palato-maxillares; by the posterior edges of their palatine lamellæ, to the ossa palati, by the transverse palate suture; by their nasal spines, to the vomer, by the spinous suture; by their sockets, to the teeth by gompho-

sis; by the internal edge of the palate-plate, to one another, by the longitudinal palate suture; on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the nostrils; between the fore-part of the nostrils and mouth, to each other, by the mystachial suture; sometimes they are connected to the ossa spongiosa inferiora, by a plain concretion or union of substance.

These bones form the greater part of the nose and of the roof of the mouth, and a considerable share of the orbit. They contain sixteen teeth, give rise to muscles, transmission to nerves, &c.

In each of the maxillary bones, of a new-born child, the external orbitar process is hollow with remarkable holes in it; there are five sockets for the teeth, of which the two posterior are very large, and, when divided by a second cross partition, make the number of sockets six *. The palate plate is cribriform about the middle †.

* Albin Osteogen. Tab. 5. Fig. 45. Ungebav. de Dentit. secund. jun. § 1.

† The superior maxillary bone is much shorter in the fœtus than in the adult, and the palatine process of it, instead of being arched, is nearly flat, and on a level with the alveolar surface. There is scarcely an appearance of the antrum maxillare; hence the remarkable change produced upon the face by the expansion of that sinus; the nose is raised, and is lengthened; the cheek bones become prominent, and by the addition of the teeth, the face becomes much longer.

Ossa Palati.

The OSSA PALATI are commonly described as two small square bones, at the back-part of the palate or roof of the mouth, though they are of much greater extent, being continued up the back-part of the nostrils to the orbit*. Each palate-bone may therefore be divided into four parts, the palate-square-bone, the pterygoid process, nasal lamella, and orbitar process.

The square bone is unequally concave, for enlarging both the mouth and cavity of the nose. The upper part of its internal edge rises into a spine, after the same manner as the palate plate of the maxillary bone does, to be joined with the vomer.

Its anterior edge is unequally ragged, for its firmer connexion with the palate process of the os maxillare. The internal edge is thicker than the rest, and of an unequal surface, for its conjunction with its fellow of the other side. Behind, this bone is somewhat in form of a crescent, and thick, for the firm connexion of the velum pendulum palati; the internal point being produced backwards, to afford origin to the palato-staphylinus or azygos muscle. The square bone is well

* EUSTACH. Tab. 47. Fig. 1. 3. 6. 7. 8. VIDUS VIDIUS, de Anat. lib. 2. cap. 2. Explicat. Tab. 6. Fig. 19. WINSLOW, Memoires de l'Acad. des Sciences, 1720.

distinguished from the pterygoid process by a perpendicular fossa, which, applied to such another in the maxillary bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes.

The pterygoid process is somewhat triangular, having a broad base, and ending smaller above. The back-part of this process has three fossæ formed in it; the two lateral receive the ends of the two plates of the sphenoid bone, that are commonly compared to a bat's wing; the middle fossa makes up part of what is commonly called the *fossa pterygoidea;* the fore-side of this palatine pterygoid process is an irregular concave, where it receives the back-part of the great tuberosity of the maxillary bone. Frequently several small holes may be observed in this triangular process, particularly one near the middle of its base, which a little above communicates with the common and proper holes of this bone already taken notice of.

The nasal lamella of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square-bone, and from the narrow extremity of the pterygoid process; where it is so weak, and, at the same time, so firmly fixed to the maxillary bone, as to be very liable to be broken, in separating the bones. From the part where this plate rises, it runs up broad on the inside of the tuberosity of the max-

illary bone, to form a considerable share of the sides of the maxillary sinus, and to close up the space between the sphenoid and the great bulge of the maxillary bone, where there would otherwise be a large slit opening into the nostrils *. From the middle internal side of this thin plate, a cross ridge placed on a similar ridge of the maxillary bone is extended; on it, the back-part of the os spongiosum inferius rests. Along the outside of this plate, the perpendicular fossa made by the palate nerve is observable.

At the upper part of this nasal plate, the palate bone divides into two processes, which I already named *orbitar;* between which and the body of the sphenoid bone, that hole is formed, which I mentioned as the last of the holes common to the sphenoid bone. Sometimes this hole is wholly formed in the os palati, by a cross plate going from the one orbitar process to the other. A nerve, artery, and vein belonging to the nostrils pass here. The anterior of the two orbitar processes is the largest, and has its fore-part contiguous to the back-part of the maxillary sinus, and its upper surface appears in the bottom of the orbit, behind the back-part of the os maxillare and planum †. It has cells behind resembling those

* Albin. de Ossib. § 88.

† The following observations occur in a Commentary upon the Osteology, written by my grandfather. "When the matter of

of the ethmoid bone, to which it is contiguous; it is placed on the aperture of the sinus sphenoidalis, so as to leave only a round hole at its upper fore-part. The other part of the orbitar process is extended along the internal side of the upper back-part of the maxillary tuberosity, to the base of the sphenoid bone, between the root of the processus azygos and the pterygoid process.

The palate square part of this palate bone, and its pterygoid process, are firm and strong, with some cancelli; but the nasal plate and orbitar processes are very thin and brittle.

The palate bones are joined to the maxillary, by the fore-edge of the palate square-bone, by the transverse palate suture: By their thin nasal plates, and part of their orbitar processes, to the same bones, by the palato maxillares sutures: By their pterygoid processes, and back-part of the nasal plates, to the alæ vespertilionum, by the sphenoid suture: By the transverse ridges of the nasal plates, to the ossa spongiosa inferiora, by contact; hence frequently there is an intimate union of the substance of these bones in old skulls: By the orbitar processes, to the ossa plana and

" an ulcer of the internal canthus of the eye eats through the " ligamentous membrane, which connects the edge of the orbit " to the eye, it naturally falls to the under part of the apex " of the conical orbit, where the orbitar process of the palate-" bone is; and once it is rendered carious, the caries proceeds " downwards in the same bone to the part of it which forms " the palate, and erodes it, and the membrane that covers it."

cellulæ ethmoideæ, by the ethmoid suture: To the body of the sphenoid bone, by the sphenoid suture: By the internal edge of the square bones to each other, by the longitudinal palate suture; and by their nasal spines to the vomer, by the spinous suture.

The palate bones form part of the palate, nostrils, orbits, and fossæ pterygoideæ, and they cover part of the sinus maxillares, sphenoidales, and ethmoidei.

These bones are very complete in a new-born infant, the nasal plates being then thicker and stronger than in adults; but the orbitar processes have not the cells which appear in the bones of adults.

When we are acquainted with the history of these bones, the reason is evident, why the eyes are so much affected in ulcers of the palate, as to be often attended with blindness, which frequently happens in an ill-managed *lues venerea*; or why, on the other hand, the palate suffers from an *ægylops* *.

Ossa Turbinata.

The OSSA TURBINATA, or spongiosa inferiora, resemble the superior ossa spongiosa in shape and

* HOFFMAN. in Ephemerid. German. cent. 1. and 2. observ. 135.

substance, but have their anterior and upper edges contiguous to the transverse ridges of the nasal processes of the maxillary and palate bones. From their upper straight edge, two small processes stand out: The posterior, which is the broadest, descends to cover some of the antrum highmorianum; the anterior rises up to join the os unguis, and to make part of the lacrymal duct.

Below the spongy bones already mentioned, there are sometimes two others, one in each nostril, which seem to be a production of the sides of the maxillary sinus turned downwards *. When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest. Besides all these, there are often several other small bones standing out into the nostrils, that, from their shape, might also deserve the name of *turbinata*, but are uncertain in their bulk, situation, and number †.

There are a number of foveoli, but no holes in the os turbinatum inferius.

They are joined to the ossa maxillaria, palati and unguis in old subjects, by a firm union of substance; and as this happens also frequently in people of no great age, some ‡ are of opinion,

* Cowper in Drake's Anthropolog. book 3. chap. 10.

† Santorin. Observat. Anatomic. cap. 5. § 9.

‡ Id. ibid. cap. 5. § 7.

that they should be esteemed part of the palate-bones; others * think, that since their upper edge is continued by a plate to a part of the os ethmoides, they ought to be esteemed to be a part of this bone.

Their use is, to straiten the nostrils, to afford a large surface for extending the organ of smelling, to cover part of the antra maxillaria, and to assist in forming the under-part of the lachrymal ducts, the orifices of which into the nose are concealed by these bones.

The ossa turbinata are nearly complete in a new-born infant.

Vomer.

The VOMER, or bone resembling a plough-share, is the thirteenth of the upper jaw, without a fellow, forming the lower and back parts of the partition of the nose †.

The figure of this bone is an irregular rhomboid. Its sides are flat and smooth. Its posterior edge appears in an oblique direction at the back-part of the nostrils. The upper one is firmly united to the base of the sphenoid bone, and to the nasal plate of the ethmoid; and, when it can

* HUNAULD, in Memoires de l'Acad. des Sciences, 1730.

† COLUMB. de Re Anat. lib. 1. cap. 8. FALLOP. Observat. Anatom.

be got separated, is hollow, for receiving the processus azygos of the sphenoid. The anterior edge has a long furrow in it, where the middle cartilage of the nose enters. The lower edge is firmly united to the nasal spines of the maxillary and palate bones. These edges of this bone are much thicker than its middle, which is as thin as the finest paper; by which, and the firm union or connexion this bone has above and below, it can very seldom be separated entire, but in a child; wherefore I shall examine all its parts of such a subject.

Its situation is not always perpendicular, but often inclined and bended to one side, as well as the nasal plate of the ethmoid bone.

The convexity of the vomer in one of the nostrils has sometimes been mistaken for a polypus in the nose.

The vomer is convex at its upper part, and then is straight, as it is extended downwards and forwards where it is composed of two plates; the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates a deep fossa is left, which, so far as the top of the curvature, is wide, and has strong sides, for receiving the processus azygos of the sphenoid bone. Beyond the arch forwards, the fossa is narrower and shallower gradually to the point of the bone, receiving for some way the nasal lamella ethmoidea; which, after the ossification is complete, is so close-

ly united to the vomer by the little processes piercing into its substance, as to prevent any separation; on which account it has been esteemed by some * a part of the ethmoid bone. The middle cartilage of the nose fills up what remains of the fossa at its fore-part.

The posterior edge of the vomer, which appears above the back-part of the palate-bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm. The lower edge of this bone, which rests on the nasal spine of the palate and maxillary bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interstice between them. This edge, and the upper one meet in the pointed fore-end of this bone.

The body of the vomer has a smooth surface, and solid, but thin substance; and towards its sides, where it is thickest, some cancelli may be observed, when the bone is broken.

It is joined above to the sphenoid and ethmoid bones, and to the middle cartilage of the nose, by schindylesis; below, to the maxillary and palate bones, by the spinous suture.

The vomer divides the nostrils, enlarges the organ of smelling, by allowing place for expanding the membrane of the nose on its sides, and

* Vesalius, Santorini, Petit in his edition of Palfyn's Anatomy; and also Lieutaud, have described this bone as a part of the ethmoid bone; and Vidus Vidius, as a part of the sphenoid bone.

sustains the palate plates of the maxillary and palate bones, which otherwise might be in hazard of being pressed into the nostrils; while the vomer is secured from shuffling to one side or other by the double schindylesis, by which it is joined to the bones above and below.

Lower Jaw.

The MAXILLA INFERIOR *, the lower jaw, consists only of one moveable bone, and sixteen teeth incased into it.

This bone, which is somewhat of the figure of the Greek letter υ, is situated at the lower part of the face, so as its convex middle part is forwards, and its legs are stretched back. It is commonly divided into the chin, sides †, and processes.

The chin is the middle fore-part, the extent of which to each side is marked on the external surface by the holes observable there, and internally by the beginning of an oblique ridge.

Beyond these, the sides appear, and are continued till the bone, by bending upwards, begins to form the processes.

On the fore-part of the chin, a transverse ridge appears in the middle, on each side of which, the

* Γένυς, σιάγων, mandibula, facies.

† That part of the side of the under jaw which is covered by the masseter muscle, is rather broader in the Negro than in the European.

musculi depressores labii inferioris, and the levatores labii inferioris, depress the bone: And below these prints, a small rising may be observed, where the depressores commence.

On the back-part of the chin, sometimes three, always two, small protuberances appear in the middle. To the uppermost, when it is seen, the frænum of the tongue is connected. From the middle one, the musculi genioglossi rise; and from the lowest, the geniohyoidei have their origin. Below the last, we see two rough sinuosities formed by the digastric muscles.

At the lower and fore-part of the external surface of each side of the lower jaw, a small eminence may be observed, where the depressor labiorum communis rises. Near the upper edge of the side a ridge runs lengthwise, to which the under part of the musculus buccinator is connected. Internally, towards the upper edge of each side, another ridge appears, from which the mylohyoidei have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and sides, are a great many deep pits or sockets, for receiving the roots of the teeth.

The number and magnitude of these sockets are various, because of the different number, as well of the teeth themselves, as of their roots, in different people. These sockets in the lower jaw, as well as in the upper one, are less deep as old age comes on; when freed from the teeth by any

means; they are some time after filled up with an osseous net-work, which at last becomes entirely solid, and as smooth as any other part of the bone; so that in a great many old jaws one cannot observe a vestige of the sockets: But then the jaw becomes less, and much narrower *. Hence we may know why the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips either fall in towards the mouth, or stand prominent forwards. When new teeth are protruded, new sockets are formed †.

The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.

The ends of the base, where the jaw turns upwards, are called its *angles;* the external surface of each of which has several inequalities upon it, where the masseter muscle is inserted; as the internal surface also has, where the pterygoideus internus is inserted, and a ligament extended from the styloid process of the temporal bone is fixed.

The processes are two on each side. The coronoid and the posterior processes or condyles ‡ terminate in an oblong smooth head, supported by a cervix. The heads, whose greatest length is transverse, and whose convexity is turned forwards,

* Vid. plate XXIII.

† Fallop. Observ. Anat.

‡ Articulatorii.

are tipped with a cartilage, as the articulated parts of all other moved bones are.

The fore-parts of the root and neck of these condyloid processes are a little hollow and rough, where the external pterygoid muscles are inserted.

The holes of the lower jaw are two on each side; one at the root of the processes internally, where a large branch of the third branch of the fifth pair of nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament extended from the temporal bone is fixed *, which saves the nerve and vessels from being too much pressed by the pterygoid muscles. From the lower side of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the mylo-hyoideus muscle and sublingual gland †. The other hole is external, at the confines of the chin, where branches of the nerve and vessels come out.

The canal betwixt these two holes is formed in the middle of the substance of the bone, and is pierced by a great number of small holes by which the nerves and bloodvessels of the cancelli and teeth pass. This canal is continued a little farther than the external hole at the chin.

On account of the vessels and nerves in the

* Weitbrecht, Syndesmolog. fig. 32. 1.

† Palfyn. Anat. Chirur. traité 5. chap. 6.

lower jaw, fractures of it may be attended with dangerous symptoms.

The surface of the lower jaw is hard and firm, except at the spongy sockets, where however it is stronger than the upper jaw. Its internal substance is cellular, without any solid partition between the cancelli in its middle. At the base, especially of the chin, where this bone is most exposed to injuries, the solid sides of it are thick, compact and hard.

The lower jaw generally receives the roots of sixteen teeth into its sockets, by gomphosis; and its condyloid processes, covered with cartilage, are articulated with the temporal bones, in a manner that is not commonly described with accuracy: For, as was already mentioned in the description of the temporal bones, not only the fore-part of the cavity between the zygomatic, auditory and vaginal processes, but also the adjoining tubercle at the root of the zygomatic process of each os temporum, is covered with a smooth cartilage, for this articulation. Here also *an intermediate moveable cartilage is placed*, which being thin in the middle, and thick at the edges, is concave on both sides; and is connected so firmly by ligaments to each condyle, as to follow the motions of the condyle; and so loosely to the temporal bone, as readily to change its situation from the cavity to the tubercle, and to return again; while the common ligament of the articulation affords space enough for such a change of place back-

wards and forwards; but, like other ligaments of the joints by ginglimus, is strong and short at the sides, to confine the lateral motions.

When therefore the teeth of both jaws coincide, the condyles are lodged securely in the temporal cavities, but their motions to either side must be confined both by the firmness of the ligaments, and the rising brims which are on each side of the cavities. When the jaw is brought directly forwards, the condyle and intermediate cartilages descend and advance forwards upon the tubercles. In this situation the lateral motions are a little more free than in the former one, from the want of rising brims to stop the condyles.

When the fore-teeth of the lower jaw are moved forwards, and to one side, the condyle of the opposite side is either advanced from the cavity to the tubercle, while the condyle of the same side remains in the cavity; or if both condyles are on the tubercles, when the jaw is moved obliquely to one side, the condyle of the side to which the motion is made, slides back from the tubercle to the cavity. When the mouth is opened by the descent of the lower jaw, the fore-part of it, where the depressing muscles are fixed, is drawn backwards, as well as downwards, while resistance is made to the angles moving backwards by the masseter and internal pterygoid muscles, and, at the same time, the external pterygoids draw the condyles and their moveable cartilages forwards; and therefore, when the mouth is opened, the con-

dyles are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this situation there is less resistance, than in any other, to the condyles luxating forwards; an accident which seldom happens, except when people are gaping too wide; and therefore the common practice of nurses, who support the jaw of infants when they are yawning, is reasonable. In chewing there is a succession of the motions above described.

Wherever moveable cartilages are found in joints, either the articulated bones are of such a figure, or so joined and fixed by their ligaments, that little motion would be allowed without such cartilages; or else some motions are necessary to the right use of the member, which the form of the articulation would not otherwise admit of. This will more fully appear after the other joints with such cartilages are described.

In a child borne to the full time, the lower jaw *is composed of two bones*, connected by a thin cartilage in the middle of the chin, which gradually ossifies, and the two bones intimately unite. In each of these bones there are five or six sockets for teeth as in the upper jaw.

From the preceding description of the teeth, the insertion of so many muscles of the tongue, and of the os hyoides, the connexion of the membrane of the tongue to the maxillary bone, and the motions of this bone; it is evident that the

lower jaw must be a principal instrument in manducation, deglutition, and speech.

For a more full account of this articulation, vid. Edinburgh Medical Essays and Observ. vol. 1. art. 11. and vol. 3. art. 13. Memoires de l'Acad. des Sciences, 1744.

Morgani Advers. anat. 11.

J. Hunter's Natural History of the Human Teeth, part 1.

Cuvier, in tom. 3. of his Leçons d'Anat. compar. has accurately described the under jaw of quadrupeds.

CHAPTER II.

OF THE CAUSES WHICH DETERMINE THE SHAPE OF THE SKULL.

Before proceeding to a detailed account of the causes which determine the shape of the skull, it may not be improper to premise a few general observations respecting the position of the human head in relation to the spine; and also upon the size and form of the human skull.

Of the position of the Human Skull with regard to the Spine.

The skull is pretty nearly equipoised upon the spine; the foramen magnum ossis occipitis, being

nearly in the centre of the basis of the skull. Thus the skull is firmly fixed on the point of support, in the erect posture; whereas, in most quadrupeds, the foramen magnum occipitis, is placed at the back of the head; or the head is connected to the neck, by its back-part, instead of the middle of its basis, and hangs, as it were, before the neck; by which quadrupeds, when in the horizontal posture, can seize what is before or above them, and, by depressing the head and neck, can reach the ground with the mouth.

Of the size and form of the Head.

The cavity of the cranium is proportioned to its contents; and hence there is much variety as to the size of the head, and also as to its form in different subjects. It is neither so broad, nor so deep at its fore-part, in which the fore-part of the brain is lodged, as at its back-part in which the back-part of the brain and smaller brain are lodged.

The skull, generally speaking, is somewhat like an egg in its shape, with the broad end behind; but there is much variety even among the individuals of the same nation, as to this circumstance, of which Plate xvi affords very strong evidence.

The greatest diameter of the cranium, is from the fore-head to the hind-head, and is equal to somewhat more than six inches, and the greatest

transverse diameter is between four and five inches and a half; and the greatest perpendicular is from the vertex to the foramen magnum occipitis.

In order to determine more accurately these different diameters, I was at some pains in measuring these in a number of skulls; of which the following is the result.

TABLE I.

MEASUREMENTS of Skulls of Britons, with the Alveolar processes and Teeth.

Greatest Breadth.	Greatest Length.	
5	$6\frac{5}{10}$	
$4\frac{9}{10}$	$6\frac{3}{10}$	
$4\frac{9}{10}$	$6\frac{4}{10}$	
$4\frac{8}{10}$	$6\frac{8}{10}$	
$4\frac{5}{10}$	$6\frac{5}{10}$	*Lunatic.*
$5\frac{9}{10}$	$6\frac{8}{10}$	
$5\frac{5}{10}$	$6\frac{5}{10}$	
$5\frac{3}{10}$	$6\frac{5}{10}$	
$5\frac{6}{10}$	$6\frac{3}{10}$	
$5\frac{3}{10}$	$6\frac{5}{10}$	
$5\frac{3}{10}$	$6\frac{6}{10}$	
$5\frac{5}{10}$	$6\frac{9}{10}$	

TABLE II.

MEASUREMENTS of British Skulls where there were no Teeth and where the sockets of the Teeth had also disappeared.

Greatest Length.	Greatest Breadth.
6	$5\frac{4}{10}$
$6\frac{9}{10}$	$5\frac{6}{10}$
$6\frac{9}{10}$	$5\frac{2}{10}$
$6\frac{4}{10}$	5
$6\frac{3}{10}$	$5\frac{1}{10}$

TABLE III.

MEASUREMENTS taken from the inside.

Greatest Length.	Greatest Breadth.	
$6\frac{2}{10}$	$5\frac{3}{10}$	*Russian.*
$6\frac{3}{10}$	$4\frac{7}{10}$	*Lascar.*
$6\frac{5}{10}$	$4\frac{8}{10}$	*Turk.*
$6\frac{6}{10}$	$5\frac{3}{10}$	*African.*
$6\frac{4}{10}$	$4\frac{6}{10}$	
$6\frac{4}{10}$	$5\frac{3}{10}$	

Explanation of Plate XVI.

This plate, which was copied from a drawing by my able assistant and friend Mr FYFE, represents accurate outlines of the skull-caps of five skulls of Britons, in order to point out the differences as to their form.

The figures placed upon the outlines of the different skull-caps, sufficiently distinguish the one skull-cap from another.

I also requested of Dr W. E. LEACH to measure several of the skulls in my possession, of different nations, with a *craniometer* invented by himself*; with which request he readily complied, and made out for me the following table:

* Dr LEACH proposes, in the Edinburgh Encyclopædia, to publish an account of his *craniometer*, which is extremely well adapted for measuring the different angles of the skull.

TABLE IV.

MEASUREMENT OF SKULLS.

Kind of Skull.	Superior basi-facial angle.	Inferior basi-facial angle.	Inio-glabellar diameter.		Anterior transverse diameter.		Posterior transverse diameter.		Distance of the foramen magnum from the Inion.		Corono-basilar diameter.	
	Degrees.	Degrees.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.
A European female,	73½	50	7	8	3	8	5	8	2	3½	4	2
A European female,	73½	0	6	0	4	0	5	5	2	3	4	5¼
A European male,	74	51	6	9	4	1	5	2	2	7	5	5
Russian male, - -	74	50½	7	0	4	4½	6	0	2	6	5	5
Negro male, - -	72½	47	7	2	3	7	5	3	2	2	5	7
Negro male, - -	69	41	7	2	4	2	5	7	2	4	5	2
Lascar male, - - -	72½	0	6	5	3	4	5	8	2	0	5	8½
Carib. (male?) - -	61	0	6	0	3	7	5	2	2	3	5	4
New Hollander (male?)	0	0	7	3	3	9	5	1	2	8½	5	6
Esquimaux, - - -	0	0	7	0	3	9	5	3	2	8	5	6
Hindoo, - - - -	81	62	6	8	3	3	4	5	2	4	4	4
A curious skull in the College Museum, supposed to be that of a Mummy, as it is filled with pitch.	0	0	8	1½	4	1½	4	5	0	0	0	0
Hottentot, - - -	0	0	7	0	4	0½	0	0	2	7	6	0

Dr BLUMENBACH of Göttingen *, after enumerating his objections to the methods which DAUBENTON, ALBERT DURER, and CAMPER have proposed for pointing out the national peculiarities of skulls, has proposed the following method, which he thinks less objectionable. He arranges his crania on a table in a row, and contemplates them behind; thus he observes the breadth and narrowness of the forehead, its arched or flat form, and the direction of the jaws and cheek-bone; and this he has called his *norma verticalis*.

But such a view may be said to be partial; and it does not present to us many of the important differences in the form of the bones of the face, especially the very different form of the orbits, and many other peculiarities in the upper jaw.

With regard to BLUMENBACH'S figures, it may be observed, that these are but poorly drawn and engraved, and communicate a very general idea of the form of the skull, but not of its smaller parts; and besides, different skulls cannot be well compared, as they are not represented in the same point of view.

In these circumstances, I thought it necessary to subjoin plates xvii, xviii, xix, and xx, which were very faithfully drawn by Dr CAMPER and Mr LIZARS, and I trust that these representations communicate a more perfect idea of the peculiari-

* Vid. Jo. FRID. BLUMENBACH, Decad. Crainor. Gotting. Vid. also his Treatise *De Generis Humani varietate nativa.*

ties of these skulls, than the most laboured verbal description could afford.

Of the causes which determine the form of the cranium, and of those causes which lead to an alteration in its shape.

There is no part of the human skeleton which is more variable in its shape, its size, and the proportion of its several parts, than the skull, and even amongst the inhabitants of the same nation.

There are some of the causes of these very remarkable differences in the skull which may be readily explained.

The form of the skull is determined by the soft parts, in proof of which, the internal table of the skull takes the exact impression of the convolutions of the brain and cerebellum, of the glands of PACCHIONI, of the ramifications of the arteries of the dura mater, and its external surface displays impressions of the action of the external muscles, as well as traces of the form of the features *.

* As the internal table of the skull only bears the impression of the convolutions of the brain and cerebellum, hence the external surface of the skull is not elevated by any part of the surface of the brain. This circumstance is a very strong objection to GALL'S doctrine, who supposes that the peculiar propensities of the individual, are indicated by the particular form of a certain part or parts of the skull.

Professor DUMAS of Montpelier, in his *Observations sur la Physionomie propre à quelques maladies chroniques*, has paid

But some anatomists do not subscribe to such an opinion, and suppose that the skull serves not only to limit the growth of the brain, but also to determine its peculiar shape. I confess that the former seems to me the more rational hypothesis.

That the cranium owes its shape chiefly to the extension of the contained parts, and the resistance of the external organs, seems proved, or at least rendered probable, as the brain and cerebellum of the fœtus are formed, long before the skull, and it is impressed by the brain.

It may be readily supposed, that the bones of the skull, which in the fœtal state are formed between the pericranium and dura mater, and which are originally in a soft and elastic state, should take on the shape of their contents.

The ossification of the skull goes on but slowly: it is not completed until the child has attained its third or fourth year, and often not until a later

much attention to the form of the head in different diseases. He has said, that in the phthisical, there is a shining brightness of the eyes, a lengthening of the line between the orbits, and a hollowness about the temples. From hydrocephalus chronicus, that the eye is thrust forward, and half of it hid under the eye-lid, and that the visage is enlarged, and altered from its natural shape.

In the scrofulous, the head is enlarged, particularly about the occiput. And he has added, that when epilepsy is connected with an organic defect of brain, this is peculiarly marked by the facial angle of 70° to 71°. In one case he observed it below 70°. Such patients, according to him, are not curable, but the epilepsy is curable when the facial angle amounts to 80°.

period: hence the bones, which are not so hard as in advanced life, more readily receive and retain the impressions of the convolutions, and other projecting parts of the brain, and are so impressed by these, that, by an attentive examination, it is easy to determine, what part of the skull has been most acted on.

Thus, upon comparing the top with the base of the skull, the latter is found very unequal in its surface, as it not only resists the extension of the brain, but also supports its weight.

Further, these impressions in the base of the skull become deeper during the progress of life.

As *general pressure* produces so manifest a change upon the form of the skull, pressure *partially applied*, may also lead *to the distortion of the skull*; and hence the skull will be expanded in the direction to which the head is inclined.

The brain of a child, by particular posture, presses more on the one part of the skull than the other. If the head be unequally balanced on the spine, it will expand in the direction to which it inclines, and one side of the skull becomes considerably more capacious than the other. This may arise from an awkward way of standing, from one leg being longer than the other, from wry neck, or any other cause which keeps the head constantly inclined to one side.

Dr CAMPER has published the case of a young woman, which shews clearly the effect of pressure: his patient carried her head to one side, so that

the brain lodged principally upon the orbit of the lower side, in consequence of which, the eye was lower down in the face than the other, and the fore-head assumed a very peculiar appearance.

That the bones derive their form from the softer parts, is also obvious, *from the remarkable alteration in the form of the jaws when the teeth have fallen out.*

The roof of the mouth, which was arched, becomes flat; the cavity of the mouth is therefore diminished, and sufficient space is not left for the tongue, and hence it is protruded out of the mouth when it is moved forwards even slightly, and it appears longer.

The distance of the chin from the nose *becomes shorter by one-sixth part of the length of the head,* and the nose and chin seem to touch each other.

The pulps of the teeth also *determine the figure of the teeth,* in the same manner as the brain determines the form of the skull.

The pulps have acquired the same form as the complete teeth, before the ossification of the teeth has begun.

When the ossification of the body of the tooth has been in part completed, the pulp is elongated, and upon the elongated pulps, the roots of the teeth are formed.

The above circumstances, seem to me to prove, that *the internal distention is the primary cause of the form of the skull and teeth.*

The influence of external pressure is also to be taken into account, which is sometimes so great as to counterbalance the internal distention.

The operation of external pressure partially applied, ought also to be taken into account. I do not pretend to refuse, that there is an original difference in the form of the skull. I am also fully persuaded, that much of this variety may fairly be imputed to the different means of compression, which the customs of different nations have introduced: hence the skull may receive a peculiar, and what may perhaps be called *national* character, from some peculiar artificial method of applying pressure *.

Hippocrates † goes further, and seems to be of opinion, that an artificial form of the head, the result of the above singular custom practised for

* Herodotus. Vid. fig 1. plate xxi, and also fig. 2. of the same plate.

Vid. Adair's Hist. of the American Indians.

Condamine, Mem. de l'Acad. des Sciences de Paris, 1745.

† Hippocrates states his opinion, that the remarkable form of the heads of the *macrocephali* is the effect of pressure; and observes, "Quum recens infans natus est, caput ejus, adhuc tenerum ac molle existens, quam celerrime constringunt manibus, coaptantesque cogunt in longitudinem augeri; quin et vinculis connectunt, ac aptis instrumentis colligant, quo rotunditas capitis prohibeatur, ac longitudo augeatur. He has added, Temporis vero progressu, natura quoque tales produxit, *ut non esset necesse consuetudine priore cogere* ‡."

‡ De Aere, Aqua, et Locis. Edit. Vanderlinden.

several generations, has at length become hereditary; and constitutes the national peculiarity.

Of the Changes in Size and Shape which the Head undergoes during the different stages of Hydrocephalus Chronicus.

The changes in size and shape which the head undergoes during the different stages of *hydrocephalus chronicus*, also afford a striking illustration of the influence of the brain upon the form of the skull, and also of the effect of posture and pressure.

In consequence of this disease, the head soon acquires a preternatural size * and form.

Before proceeding to endeavour to explain the form of the skull in the different stages of hydrocephalus chronicus, it may not be improper to observe, that when the forehead is naturally very prominent, as we observe in some families, it becomes very remarkably so from hydrocephalus chronicus †.

The uniform and equal growth of every part of the bones of the brain-case may be stunted, or its shape distorted by posture.

* I have seen the skull of a person who died from hydrocephalus, which measured fifty inches in circumference.

† Vid. Case which I published in Dr Duncan's Annals of Medicine for 1803.

I have described * two cases, which afford striking examples of the operation of posture and pressure in modifying the form of the head. In the former, from the boy sleeping most frequently on his back, the back-part of the head on which he rests has become flat: and as, in the latter case, the child was suckled at one breast only, the pressure of the mother's arm prevented the one side from bulging out so much as the other.

I have endeavoured to shew that the brain serves as a mould upon which the skull is formed; and the following observations seem to me to afford still farther evidence in support of that opinion.

It seems probable, that in the hydrocephalus chronicus, there is not the usual balance betwixt the actions of the arterial and absorbent systems. The arteries of the brain do not secrete the usual quantity of medullary matter, while the absorbent vessels, in consequence of distention and pressure, act much more powerfully than usual, and remove a considerable portion of the brain.

In many instances, on dissection, almost the whole substance of the brain has been found removed; and its cavities have been so distended, that the brain itself seemed only a thin lining to the dura mater.

In such a morbid state, the water contained within the ventricles will push the brain outwards, and separate the pieces of the cranium to a great-

* Vid. Dr DUNCAN's Annals of Medicine for 1803.

er or less distance, in proportion to the quantity of water effused.

The preceding observations appeared to me necessary to the more perfect understanding of the changes which the head undergoes, in shape and size, in the successive stages of hydrocephalus chronicus.

Keeping these in view, and marking the progress of ossification, with the mode of attachment of the different bones of the skull, the phenomena that present themselves appear to admit of a satisfactory explanation.

It is obvious, that where the internal pressure is greatly increased, and the bones of the skull give way, that this enlargement must be unequal, owing to the unequal resistance.

As the chief circumstances, upon which this unequal resistance depends, in my opinion are the progress of ossification, and the connection of the different bones of the head, I shall now proceed to explain the effect of these more fully.

From the imperfect ossification of the bones of the head, when the child is born, it follows that when the disease originates while the fœtus was *in utero*, the skull must more readily give way, and more readily acquire a large size, than when the disease occurred at a later period of life, and where the bones of the skull were burst assunder, after having been previously united.

In proof of which, the head of one of my patients, though it had attained a large size before birth, increased six inches in circumference in the course of nine months; and, in another instance, the child, when nine months old, required a hat fit for a child four years old.

As the skull after puberty rarely gives way, the brain must be much compressed; which compression speedily leads to stupor, convulsions, and death, or to the hydrocephalus acutus.

The form of the skull of the fœtus is very different from that of the adult: in the former, *the skull projects remarkably at the original centres of ossification of its component pieces* *, and hence the the upper part of the skull of the fœtus is not so round as that of the adult.

In the adult, those prominences which are very apparent in the fœtus disappear, owing to the gradual growth and alteration of the shape of the brain, which serves as a mould on which the skull is formed; the skull adapting itself to the form of the brain.

But as, in consequence of hydrocephalus, the growth of the brain is checked, or in some measure suspended, the brain does not acquire its usual form; and as the brain is pushed outwards from the accumulation of water within it, the bones of the cranium, though they increase in size, *retain the form they had when the child was*

* Vid. Plate xxi.

born; and the ossific spiculæ, instead of describing portions of spheres, as they do at a later period of life, describe only straight lines from their centres of ossification *.

Hence the head of a child labouring under hydrocephalus chronicus, notwithstanding its increased bulk, preserves for some time at least the form it had at birth *.

Some of the prominences on the head are more apparent than others: those on the fore-head especially are apparent even to the most superficial observer: the others also may be discovered by a careful examination.

These prominences, in cases of hydrocephalus, correspond in situation, as in the fœtus, with the original centres of ossification of the different pieces of the cranium *.

The os frontis in the fœtus is composed of two pieces. Two projecting parts are seen in the foreheads of all children labouring under hydrocephalus chronicus. There is also *a well-marked projection on each side of the head,* corresponding with the centres of ossification of the parietal bones.

There is only one projection in the upper and middle part of the os occipitis, which corresponds in situation with the largest piece of the os occipitis of the fœtus.

It also frequently happens, that there is a *marked inequality in the size of the projections on the op-*

* Vid. Plate xxi.

posite sides of the head, which gives the head a distorted appearance; and in some instances, such inequality in the growth of the cranium takes place at the back-part of the head; in others, in the forehead.

In one of the cases which I met with, that part of the head which is opposite to the centre of ossification of the right parietal bone, is more prominent than the same part of the skull on the left side; but the skull on the right side, underneath the prominent portion, is almost flat; whereas the corresponding portion on the left side bulges out, and forms a semicircular line downwards towards the neck.

In another case, *one side of the os frontis is much more prominent than the other*, and to such a degree, that if the profiles of both sides of the head were taken, no one would imagine them to represent different views of the same head: the one resembles the profile of a child whose *head is a little larger than usual;* whereas the other, from the forehead being very prominent, bears all the characters of the head of a child labouring under hydrocephalus chronicus.

May not the above fact be attributed to a larger quantity of water being effused on one side of the head than the other; the cause of which has been well explained in the following letter from my ingenious colleague Dr RUTHERFORD, to my Father: "I have seen," says he, "one of the ventricles much enlarged and full of water, while

the other remained of its natural capacity, and contained hardly any water. This appearance, I should however impute not to the obliteration or obstruction of the communication between the lateral ventricles, but to one side of the brain being more affected with disease, more flaccid and tender than the other; in consequence of which, a greater exudation had taken place from the vessels of this part, and the sides of the ventricle had yielded more readily to the pressure of the water, as it was effused."

Such, in general, is the state of the head in the first stage of hydrocephalus chronicus; but it is proper to remark, that cases occur where some parts of the head are below the level of the others, which is probably owing to the ossification not being completed at those places.

During the progress of the disease, the head exhibits many striking varieties as to form and size. It never preserves its natural form. It acquires an unusual breadth; but especially at those parts *which correspond with the centres* of ossification of the parietal bones, and also *in the forehead.*

The effusion of a watery liquor into the cavities of the brain, which takes place to a greater or less degree in different instances, produces these effects*.

* The undulation of a fluid within the head, may be distinctly perceived at the sutures, if the watery liquor has been effused between the membranes of the brain; nay, even where it is ef-

The former change is owing to the separation of the parietal bones; the latter is the consequence of the separation of the upper part of the pieces composing the os frontis; (for the lower parts of the pieces of that bone, on account of their connections with other bones which are ossified at an early period of life, cannot recede from each other to any distance); and hence the face, instead of being nearly oviform, somewhat resembles a triangle, of which the brow makes the basis, and the chin the apex.

As the disease advances, *the forehead becomes unusually prominent*, to such a degree, as often to prevent the unfortunate sufferer from seeing objects above the level of his eyes.

During the continuance of the hydrocephalus chronicus, the distance from ear to ear, or the transverse diameter of the head is increased, and the width of the head is most remarkable between the centres of ossification of the parietal bones. A disunion takes place between the upper portions of the pieces of bone which compose the os frontis, which is the cause of the very remarkable breadth of the upper part of the forehead; and hence the forehead is somewhat of a conical form, the apex

fused within the ventricles, especially if the quantity of it be large; as in such cases, in consequence of the pressure by distention, a great part of the brain is absorbed, and a communication is formed betwixt the water which is effused between the membranes, and that within the ventricles of the brain.

of the cone being at the root of the nose, and the base of it at the upper part of the forehead.

From the continuance of the disease, owing to the water contained within the head elevating the *bregma*, and membrane between the parietal bones, the form of the head is still farther changed; *its upper part becoming somewhat of a conical figure.*

During the progress of the ossification, and from the internal distention continuing to exert its influence over the growing osseous fibres of the skull, which on account of their length and weakness, do not oppose as much resistance to the internal distention as the centres of ossification; hence the next change, is the *bulging out of the bones at the sides of the prominences*, which is the consequence of a very large collection of water within the head, and only occurs when the disease has been of two or three years standing.

The bones bulge out at the sides of the original centres of ossification of the pieces of the skull, which form the most resisting points; and hence, in this stage of the disease, the prominences in the skull corresponding with the original centres of ossification of the pieces of the cranium, are less apparent than in the head of a child who has laboured under hydrocephalus for a few months only.

It is hardly necessary to observe, that these changes in the form of the head take place more rapidly in some cases than in others.

The disease at its commencement, and for some time after, affects only the bones of the cranium; but, in process of time, the bones of the face are also enlarged, and become distorted, especially those of the orbits: and the distances between their outer angles are much greater; in one of the cases, it was greater by 1 inch and $\frac{1}{4}$th, than in most men of twenty years of age.

Of the Progress of Ossification in the Sutures.

Should the unfortunate patient linger for some years under hydrocephalus, nature endeavours to give protection to the brain, by completing the ossification of the skull; the progress of which, and all the symptoms which it gives rise to, I shall endeavour to describe.

This process, probably from the diseased state of the vessels, takes place imperfectly and unequally; so that, in some instances, instead of the whole void being filled up by bony matter, for many months only a few pieces of bone, of unequal sizes and irregular figures, are formed in some of the sutures; and in other instances, as in Case I., the ossification is not completed for years.

This gives rise to the sensation which the mother of the boy nine years of age, so strongly expressed: she said, that her son's head, about eighteen months before, seemed to her as if it had been broken in several places; but now, that the whole was consolidated: for the detached pieces

of bone in the membranes uniting, the bones of the cranium have, in the progress of ossification, adhered firmly to them.

The ossification takes place at different times in the different sutures.

The membrane uniting the pieces of the os frontis, is generally ossified when the child is between its twelfth and twentieth month.

The membrane betwixt the os occipitis and parietal bones, is not ossified until a much later period of life; and the sagittal and coronal sutures were not ossified in the boy of nine years of age.

These membranes are of unequal breadth; that between the two pieces of the os frontis, and that between the parietal bones being broader than the others, allow these bones to recede from each other to a considerable distance, and hence, as has been already observed, the head acquires an extraordinary breadth. From a similar cause, the os occipitis is also protruded; and were it not owing to the patient generally resting on the back-part of his head, that part of the head would also become very prominent.

In short the head acquires its unusual bulk, in part from the greater size of the pieces of the cranium-case, and also from the ossification of the membranes which unite these different pieces together.

Having described the changes which take place in the size and form of the head, during the suc-

cessive stages of hydrocephalus chronicus, I shall conclude, by adding a few remarks on the thickness of the skull, and on the changes which the other bones of the body undergo in consequence of this disease.

On account of the great size of the head, the bones of the cranium are generally thinner than in the healthy state; and a case is quoted by VAN SWIETEN *, in which the bones of the cranium became nearly transparent.

In some instances, every portion of the skull has not been ossified, some spots of the brain being covered by membrane instead of bone †.

When sheep are attacked by hydrocephalus, or when hydatids are lodged within their brains, the earthy part of the skull opposite to the seat of the disease is removed by absorption; that part of the skull becomes soft, feels like a piece of wet pasteboard, and may be cut through, without turning the edge of the knife.

But in the human subject, the reverse of what has been already described, sometimes, though rarely, takes place; for the bones of the skull, instead of becoming thinner, become thicker than common, in consequence of hydrocephalus chronicus ‡.

* "Ossa tamen capitis tenuia erant adeò, ut irradiante lumine pellucerunt, sic ut interiora capitis videri potuerint." Vid. vol. iv. p. 122. quarto edition, published at Leyden.

† Vid. Plates of Dr BAILLIE's Morbid Anatomy, Fasc. 10.

‡ Vid. DU VERNEY, Traité des Maladies des Os, tom. ii. pag. 8.

Morgagni* informs us, that even the other bones of the body partake of the disease, and are much altered in shape. Such a change, I believe, rarely occurs; although I have no doubt, that in almost all cases of hydrocephalus chronicus, the bones of the skeleton are, as the soft parts, of a more slender form, thinner and smaller than usual; or that, even supposing the head of the usual size, the rest of the body will be found not to bear the same proportion to it as in a healthy child.

Observations on the Smaller Varieties in the Form of the Skull, and on Craniometers.

From what has been stated respecting the form of the skull, and also respecting the various causes which determine its particular shape, it is evident, that the shape of the skull may be readily altered by a great variety of causes; as by external injury, by particular posture, or by disease.

There are many distinctions as to the shape of the skull, which have not been described, owing probably to our not being provided with a machine adapted to that purpose. Thus, for example, there is not a skull in a hundred, which is symmetrical, in which the opposite sides are exactly equal and parallel to each other. This observation holds true, even with regard to the os frontis,

* Vid. Epist. xii.

though in the adult it consists only of one bone; and it holds true with regard to the bones which surround the cavities of the nose, of the orbits *, and also respecting the bony part of the mouth.

Upon examining the under surface of the skull, the above observation also holds true, as may be seen by drawing a line from the more prominent part of the os occipitis, through the middle of the foramen magnum, ossis occipitis, and the bony palate, to the most prominent part of the upper jaw †.

It would lead to a very long detail, entirely foreign to the object of mere Outlines on Anatomy, to point out all the defects as to the symmetry of the skull; many of which are obvious in the subjoined plates. I shall therefore content myself, by submitting to the reader, a machine by which these varieties in the form of the skulls, may be observed, and represented with truth upon paper.

The machines which have been employed for measuring the different angles of skulls, are imperfect, and may on some occasions mislead; for it is evident, that any little rising of the skull must alter the angle, which is taken by a wooden or metallic ruler, laid along the most prominent part of the os frontis and os maxillare superius, and crossed by another laid horizontally across the

* There is no part of the skull which is so different as to its form, as the orbit *. That of the Hottentot very much resembles the orbit of the Chinese.

† Vid. Plate xx. A.

* Vid. plates 18th, 19th, and 20th.

meatus auditorius externus: these instruments being made of unyielding materials, do not adapt themselves to the inequalities of the surface of the skull.

In illustration of what I have affirmed, I shall take the os frontis as an example.

In the os frontis there are certain cavities, called *sinuses*, which scarcely exist at the period of birth, and which, during the progress of life, are constantly becoming larger: the common craniometer when applied to the os frontis, is laid along the most prominent part of this bone; it therefore gives the angle which is formed by the projecting os frontis opposite to the frontal sinus, but not the angle formed by the os frontis above the frontal sinuses; so that the os frontis has been sometimes described as being very prominent, while in truth it was the reverse, the projection being caused by the large frontal sinuses, and not by the whole os frontis; and I have seen several persons whose foreheads were remarkably prominent at the frontal sinuses, but in which, the upper part of the os frontis retreated nearly as much as in the greatest number of African skulls.

The above observation applies also to the skulls of quadrupeds; for in these the frontal sinuses are much more capacious and extensive, than in the human body: in some, as the elephant, they extend over the whole skull.

Such are the imperfections of the present *craniometers;* for which in my opinion, the one repre-

sented in plate xx. A. might be substituted. This craniometer consists of four pieces of wood or brass, divided into inches, and properly subdivided, and one of which may be moved either in a horizontal or in a perpendicular direction; and for the sake of still greater accuracy, a Nonius or Vernier is added to one of the sides. Holes are perforated at each inch or half inch of the sides of the instrument, for the purpose of affixing silk threads, which are stretched from one side of the instrument to the other, by which a number of small squares are formed. By placing a skull behind these squares, as in plate xx. A. the form of the skull is seen with accuracy by dividing paper in a similar way. It may be copied, or reduced with mathematical accuracy, and every deviation from the most common shape, may be traced and represented on paper, by one who has attained but little proficiency as a draughtsman.

Explanation of Plate 17*th.*

This engraving is a fac simile of a drawing by the late justly celebrated Dr Peter Camper.

AA, point out the os frontis.
B, one of the ossa parietalia.
C, the os occipitis.
D, the os temporis.
E, the temporal process of the sphenoid bone.
F, the os malae.
G, the os maxillare superius.
H, one of the ossa nasi.
I, the under jaw.

K, the angle of the under jaw.

L, the condyle of the under jaw.

M, the zygomatic process of the temporal bone joining with the zygomatic process of the cheek-bone.

N, the sagittal suture.

OO, the squamous suture.

PP, the lambdoidal suture.

RR, the teeth.

Explanation of Plate 18*th.*

In this engraving, the skulls are represented in such a point of view, as seems to me to give the most complete idea of their form.

Fig. 1. is a remarkably well formed skull of a native of this country, of twenty years of age.

1 points out the os frontis.

2 one of the ossa parietalia.

3 one of the ossa temporum.

4 4 the ossa malarum

5 5 the ossa maxillaria superiora.

6 6 the ossa nasi.

7 one of the ossa unguis.

8 8 8 8 the incisores teeth.

9 9 the canine teeth.

10 10 the smaller molares.

11 11 11 the three larger molares.

Fig. 2. this engraving was copied from the skull of a Russian, which is nearly of a globular figure.

Fig 3. this engraving was copied from the skull of a Turk. The globular form of the skull, and great size of the bones of the face, and especially of the ossa maxillaria superiora, are the most striking features of this skull.

Explanation of Plate 19th.

Fig. 1. was copied from the skull of a Hindoo, which I received from Mr Thomas, surgeon in London.

Fig. 2. was copied from a skull of an Esquimaux, which was sent to my colleague Professor Jameson. The fore-head is narrow, the skull flat at its sides, and the superior maxillary bones remarkably large.

This skull differs a good deal from those represented by Blumenbach *.

Fig. 3. was copied from the skull of a Negro.

This view does not give a good idea of the cranium of the Negro; for the retreating forehead, and flatness of the occiput, are the most remarkable features of it.

The great size of the bones of the face and of the teeth, is very apparent.

Explanation of Plate 20th.

In this plate three very remarkable skulls are represented.

Fig. 1. represents the skull of a Carib, of the Island of St Vincent, which, in consequence of pressure having been applied to the forehead, is much distorted. It may be mentioned, that this specimen perfectly agrees in its characters with a skull of the same nation, in the museum of Mr Cline; and also with one in the possession of Dr W. E. Leach.

The forehead is remarkably flat, as also the sides of the head.

There is a ridge on the vertex of the skull.

* Vid. Cartwright's Journal during a residence of nearly five years on the coast of Labrador.

The bones of the nose are very long, and the distances between the orbits are of a very peculiar shape, and differently placed from those of the other skull.

The under part of the occipital bone is much flattened.

Thibault, De Chanvalon and Labat bear testimony, that this very remarkable form of the skull, is the result of pressure artificially applied.

Labat, tom. ii. p. 72. has observed,—"Les Caraibes sont tous bien faits et bien proportionnés; les traits du visage assez agréables. Il n'y a que le front qui paroit un peu extraordinaire, parcequ'il est fort plat et comme enfoncé. Ils ne naissent point comme cela, mais ils forcent la tête de l'enfant à prendre cette figure, en mettant sur le front de l'enfant nouveau né une petite planche liée fortement derriere la tête, qu'ils y laissent jusqu'à ce que le front ait pris sa consistence, et qu'il demeure applati, de manière que sans hausser la tête ils voyent presque perpendiculairement au dessus d'eux."

Fig. 2. was copied from a remarkably fine specimen of a New Hollander, for which I am indebted to Mr Harrison of London.

The engraving is so accurate and so characteristic, as to require no illustration.

Fig. 3. was copied from a portion of the skull of a Mummy, which is filled with pitch.

It is the most remarkable skull in point of form, which I have ever seen, or seen represented.

It is narrower than common between the external angular processes of the frontal bones, measuring only three inches and three quarters: the transverse diameter behind, between the junctions of the squamous and lambdoidal sutures on the opposite sides of the skull, measured only four inches and a quarter, whereas most skulls, at the same place, measure six inches or nearly so: the

distance from before to behind, was, by the callipers, eight inches and three quarters; and the upper part of the skull *forms an arch*, of which the middle of the os frontis constitutes one extremity, and the most prominent part of the os occipitis, the other. From the most prominent or highest part of the arch, near the middle of the sagittal suture, to the fore-part of the foramen magnum ossis occipitis, the distance was $5\frac{5}{8}$ inches, being little more than $\frac{1}{8}$th of an inch greater than in most skulls: hence it appears that the pressure applied to the sides of this skull, had added very little to its depth.

Such a remarkable deviation from the natural form of the skull, and a form which is so different from the skulls of other mummies, which have been carefully examined by BLUMENBACH, MIDDLETON, &c. could only, in my opinion, have been the effect of lateral pressure artificially applied.

Explanation of Plate 20th A.

This plate represents the under-part of the skull of the Carib, in order to shew how much it has been distorted, probably also by pressure artificially applied.

This plate also represents the Craniometer applied.

ABCD, the different sides of the instrument, which are divided into inches and half inches.

E, the nonius applied.

FFFF, threads stretched from the opposite sides of the craniometer.

G, points out its occiput.

H, the alveolar processes of the skull.

I, the foramen magnum ossis occipitis.

KK, the occipital condyles.

L, the cuneiform process of the os occipitis.

M, the palatine plate of the os maxillare superius.

N, the zygoma.

Explanation of Plate 21st.

This very highly finished engraving by Mr James Heath, taken from a drawing by Mr Fyfe, is a very faithful portrait of the skull of a child that died from a large collection of water within the head.

The bones of the skull were separated from each other to a considerable distance; and ossification had begun in several places upon the membranes uniting the bones.

The engraving has been so repeatedly alluded to in the preceding pages, as to render further explanation superfluous.

CHAPTER III.

MUSCLES SITUATED UPON THE BACK-PART OF THE TRUNK OF THE BODY.

The muscles have been arranged by some authors into classes, according to their situation, and by others, according to their several uses.

Albinus has divided the muscles of *the back* into four layers.

1*st Layer.*

There are two muscles which cover the whole of the back, the Dorso-acromialis, or *trapezius*, and the Lumbo-humeralis, or *latissimus dorsi*.

2*d Layer.*

NEW NAMES, *Descriptive of the situation of the Muscles.*	OLD NAMES.
Dorso-Scapularis,	The rhomboideus major.
Dorso-Costalis,	The serratus posticus superior.

NEW NAMES, *Descriptive of the situation of the Muscles.*	OLD NAMES.
Lumbo-Costalis,	The serratus posticus inferior. The under part of the serratus magnus.
Tendons of the Sacro-Costalis,	The tendons of the sacro-lumbalis.
A portion of the Sacro Spinalis, or	Of the longissimus dorsi.
Transverso-Spinalis Dorsi, or	A part of the semi-spinalis dorsi. The spinalis dorsi. The broad tendon, common to the latissimus dorsi and serratus posticus inferior.
The back-part of the Ilio-Abdominalis, or	Of the obliquus internus abdominis. The intercostales externi. The coccygeus. The levator ani. The spincter ani.

3d Layer.

	The spinalis dorsi.
Part of the Transverso-Spinalis Dorsi, or	Part of the semi-spinalis dorsi.
Sacro-Spinalis, or	The longissimus dorsi.

NEW NAMES, *Descriptive of the situation of the Muscles.*	OLD NAMES.
TENDONS OF THE SACRO-COSTALIS, OR	Of the sacro-lumbalis.
	The common fleshy head of the longissimus dorsi and sacro-lumbalis.
	Tendon covering and partly giving origin to the fleshy head.
	Part of this tendon upon the longissimus dorsi.
THE LUMBO-ABDOMINALIS, OR	The transversalis abdominis.
	The intercostales externi.
	Portions of the intercostales externi, called by ALBINUS, *levatores costarum.*

4th Layer.

THE TRANSVERSO-SPINALIS DORSI, OR	The semi-spinalis dorsi.
	The multifidus spinæ.
	The intercostales interni.
	The intertransversalis lumborum, interspinalis lumborum.

The above named muscles, according to their uses, may be divided into the following classes:

1st, *Into the muscles proper to the spine.*

2d, *Into muscles which move the ribs.*

3d, *Into muscles which move the head.*

4th, *Into muscles of the shoulder.*

Lastly, There is a muscle implanted in the back, the *latissimus dorsi*, which is a muscle of the arm.

Sect. I.

MUSCLES OF THE SPINE.

Sacro-Spinalis, or *Longissimus Dorsi.*

This long conical-shaped thick mass of flesh, fills up the hollow between the spine and angles of the ribs.

It is connected in common with the sacro-costalis, by a strong tendon, with the os sacrum, and spinous processes of the lumbar vertebræ, and is fixed by distinct tendons into the lower edges of the ribs, except the two lower, and into the transverse processes of the dorsal vertebræ, by samll double tendons.

Sacro-Costalis, or *Sacro-Lumbaris.*

This muscle may be said to form a part of the preceding muscle: it takes its origin in common

with it, from the side of the spinous processes of the os sacrum, and from the spinous and transverse processes of the lumbar vertebræ. The preceding muscle is interposed between this muscle and the spine, and is fixed by flat tendons into the angles of all the ribs.

This and the preceding muscle, are the principal extensors of the trunk of the body.

There is a muscle joined to the inner side of the preceding, which arises from eight of the lower ribs, which from thence has been named the *additamentum ad sacrum lumbarem.*

This muscle assists the former in maintaining the trunk of the body erect.

Transversalis Colli.

This muscle, which arises from the transverse processes of the six uppermost dorsal vertebræ, and is fixed into all the transverse processes of the vertebræ of the neck, except the first and last; pulls the neck backwards and sidewise.

Cervicalis Descendens.

This muscle forms a part of the sacro-spinalis, and is fixed to the transverse processes of the 4th 5th, and 6th cervical vertebræ, by three distinct tendons.

It assists in turning the neck obliquely backward.

Spinalis Dorsi.

This muscle arises from the spinous processes of the two upper lumbar, and three lower dorsal vertebræ, and is fixed into the spinous processes of the 2d, 3d, 4th, 6th, 7th, and 8th dorsal vertebræ.

This muscle is also an extensor, and serves to fix the vertebræ to each other.

Transverso-Spinalis Colli, or *Semi-Spinalis Colli.*

This muscle which arises from the transverse processes of the seven superior dorsal vertebræ, and is connected to the spinous processes of the 2d, 3d, 4th and 5th cervical vertebræ, extends the neck backwards, and pulls it to a side.

Transverso-Spinalis Dorsi, or *Semi-Spinalis Dorsi.*

This muscle arises from the transverse processes of the 8th, 9th, and 10th dorsal vertebræ, and is fixed into the spinous processes of the two last cervical, and five first dorsal vertebræ, by

tendons, and serves to pull the spine obliquely backwards.

Besides the above muscles, there are two rows of muscular fibres between the spinous processes, and also between the transverse processes, called INTER-SPINALES and INTER-TRANSVERSALES, and there are also muscular and tendinous fibres which arise from the spinous processes of the os sacrum, from the oblique and transverse processes of the lumbar and dorsal vertebræ; and from the four lowest cervical vertebræ, and these fibres are fixed by distinct tendons into the spinous processes of all the vertebræ, with the exception of the first, and constitute the *multifidus spinæ* of some authors.

These muscular fibres draw the spine directly backwards.

SECT. II.

OF THE MUSCLES WHICH MOVE THE HEAD.

Movements of the Head.

THE head is articulated with the atlas, or first vertebra of the neck, by a *ginglymus joint*, on which it is moved backwards and forwards.

The head, (as has been before described), is also connected with the second vertebra of the neck,

and performs upon that vertebra its lateral motions; and the head is also inclined to right and left, by means of the five lower cervical vertebræ, the articular surfaces of which being turned backwards, admit of a free lateral motion.

By the three following muscles, the head is drawn backwards, or to a side, when the muscle of one side only is thrown into action:

Cervico-Mastoideus, or *Splenus Capitis.*

This muscle is placed between the trapezius and complexus major; it is flat, and somewhat like a surgeon's splent in form. It arises from the spinous processes of the four uppermost dorsal vertebræ, and five lowest cervical vertebræ; and proceeding upwards, is fixed into the occipital ridge and mastoid process of the temporal bone, and also into the transverse processes of the five uppermost cervical vertebræ.

Trachelo-Occipitalis, *Biventer Cervicis of* Albinus, or *Complexus Major.*

This muscle arises, by tendons, from the transverse processes of the four lower cervical vertebræ, and seven uppermost dorsal vertebræ. It forms a thick fleshy mass, in the middle of which there

is a tendon, and at last terminates in the lower occipital ridge.

TRACHELO-MASTOIDEUS, or *Complexus Minor.*

This muscle arises from the five lowest vertebræ of the neck, and transverse processes of the three uppermost vertebræ of the back, and is fixed into the mastoid process of the temporal bone.

AXOIDO-ATLOIDEUS, or *Obliquus Capitis Inferior.*

This muscle, which arises from the spinous process of the second cervical vertebra, and is fixed into the transverse process of the atlas, assists in rolling the head.

ATLOIDO-SUB-MASTOIDEUS, or *Obliquus Capitis Superior.*

This muscle, arises from the transverse process of the atlas; it passes upwards and inwards, and is fixed into the end of the lower part of the occipital ridge.

The muscle assists in rolling the head to one side, and in pulling it backwards.

By the two following muscles, the head is drawn backwards:

AXOIDO-OCCIPITALIS, or *Rectus Capitis posticus major.*

The origins of this muscle are, the spinous and transverse processes of the second cervical vertebra, and is fixed into the lower part of the occipital ridge, at the outer side of the rectus minor.

ATLOIDO-OCCIPITALIS, or *Rectus Capitis posticus minor.*

This muscle arises from the middle of the protuberance which is found instead of the spinous process of the first vertebra of the neck, and is fixed into the lower occipital ridge.

The two following muscles are the antagonists of the former:

TRACHELO-SUB-OCCIPITALIS MAJOR, or *Rectus Capitis anticus major.*

This muscle arises from the second to the sixth cervical vertebra, and is fixed into the cuneiform process of the occipital bone, where it joins with the sphenoid bone.

TRACHELO-SUB-OCCIPITALIS MINOR, or *Rectus Capitis anticus minor.*

This muscle lies under the former, it arises from the anterior part of the atlas, and is fixed into the occipital bone, near the condyle.

ATLOIDO SUB-OCCIPITALIS, or *Rectus Capitis lateralis.*

This muscle takes its origin from the anterior part of the transverse process of the atlas, and is fixed into the side of the cuneiform process of the occipital bone.

This muscle pulls the head to one side.

PRÆDORSO-ATLOIDEUS, or *Longus Colli.*

This muscle is attached to the three uppermost dorsal vertebræ, and to the transverse processes of the four undermost cervical vertebræ; and it is fixed to the fore-parts of the cervical vertebræ, by tendons.

It tends, with its fellow, to bend the neck forwards; and when only one of the muscles acts, the head is pulled to one side.

Beside the above muscles, which more properly belong to the head, there are certain muscles of the shoulder, viz. the *trapezius, sterno-cleido-mas-*

toideus, and the muscles arising from the sternum, which are fixed into the larynx, os hyoides, and under-jaw, which act upon the head.

Some of the muscles of the shoulder, arise from the fore and back parts of the trunk of the body. These muscles will be described in a subsequent chapter, under the section *Shoulder*.

MUSCLES ON THE FORE-PART OF THE TRUNK OF THE BODY.

The muscles of the fore-part of the chest, viz. the *greater pectoral muscles* and *serrati*, are muscles of the superior extremity. The *lesser pectoral muscle*, is a muscle of the superior extremity, or it is sometimes employed in a deep inspiration. These muscles will be described under the head of Superior Extremities. The external and internal strata of *intercostal muscles*, are muscles of inspiration, and will be mentioned under the head Respiration.

The muscles of the abdomen, are included in the description of the Organs of Digestion.

The muscles of the fore-part of the Head, will

be described under the articles Deglutition, Muscles of the Eye, Ear, and Skin.

Explanation of Plate 22d.

This very beautiful plate, which is a fac simile of a drawing by MICHAEL ANGELO BUONAROTTI, in the collection of JOHN CLERK, Esq. represents the muscles of the head, neck, thorax, and abdomen, in action.

CHAPTER IV.

BURSÆ MUCOSÆ OF THE TRUNK OF THE BODY.

THE bursæ mucosæ of the extremities of the body, are larger and more numerous than those of the trunk.

There is a small bursa which covers the *superior oblique muscle of the eye;* there is a bursa under the tendon of each head of the *digastric muscle of the under jaw.*

There are two small bursæ under the *masseter muscle,* and one under the *sterno-hyoid muscle.*

There is a bursa situated between the hook-like process of the internal pterygoid process, and the tendon of the *circumflexus palati muscle.*

There is also a small bursa, proper to the *sterno-hyoideus muscle*, placed between the os hyoides and larynx.

There is also a small bursa under the *greater pectoral muscle*.

CHAPTER V.

OF THE LIGAMENTS OF THE TRUNK OF THE BODY.

As my Grandfather, in his very faithful descriptions of the bones of the trunk of the body, has also described the ligaments which unite the bones; I shall make this chapter a very short one.

Ligaments of the Head.

The condyle of the under-jaw is retained in its place by a capsular ligament, which is connected with the temporal bone.

There is also a lateral ligament extending between the posterior maxillary foramen, and the petrous portion of the temporal bone.

Within this joint, there is an *interarticular cartilage*, which is thinner in the centre than in the circumference.

The skull is fixed to the cervical vertebræ, by a general capsular ligament, which surrounds the condyles.

There is a perpendicular ligament extending between the occipital bone, and upper part of the tooth-like process of the second cervical vertebra.

There are also two ligaments, one from each side of the tooth-like process, which have been named *lateral ligaments*, which are inserted into the occipital bone before the condyles.

There is also a circular ligament arising from the edge of the foramen spinale, which is inserted into the edge of the foramen magnum.

Ligaments of the Vertebræ.

The tendons between the spinous and transverse processes of the vertebræ, serve the purpose of ligaments, and have been named from their situations.

A strong ligament, with fibres which follow a longitudinal direction, runs along the fore-parts of the vertebræ.

This ligament becomes broader the nearer it approaches the os sacrum, and serves to bind together and to defend the vertebræ.

The above ligament is formed by a number of shorter intervertebral ligamentous fibres.

The *theca vertebralis* is also lined by a ligament; it extends from the foramen magnum ossis occipitis, to the os sacrum.

There is an elastic yellow ligament passing between the spinous processes of the neck, which corresponding ligament is remarkably strong in the elephant, and in some birds, and tends by its elasticity to save muscular power.

There are ligaments which are peculiar to the atlas, and to the last lumbar vertebra.

There is an internal transverse ligament of the atlas, which serves to keep the processus dentatus in its place, and to prevent it from passing backwards, and compressing the spinal marrow.

There are *capsular ligaments* of the oblique processes of the lowest lumbar vertebræ, and which fix this bone to the sacrum, and also *transverse ligaments* for uniting the lowest lumbar vertebræ to the posterior and internal surfaces of the os ilium.

Ligaments of the Ribs.

The ribs are united before to the sternum or to cartilages, and behind by *capsular ligaments* to the vertebræ.

The cartilages of the ribs are united to each other by a *perpendicular ligament*.

The heads of the ribs are retained in their places by *capsular ligaments*, by which they are joined to the vertebræ and intervertebral cartilages.

The ribs are united by their tubercles to the transverse processes of the dorsal vertebræ, by *capsular ligaments*.

There are also *internal and external ligaments of the necks of the ribs*. The former originate from the superior margin of the neck of the ribs, and are fixed into the inferior surfaces of the transverse processes of the dorsal vertebræ immediately above; and the latter, which arise from the upper margin of the necks of the ribs, are inserted into the external margin of the inferior oblique process of the vertebræ above.

Ligaments of the Breast-Bone.

THERE is a thick ligamentous sheath which covers the breast-bone, the fibres of which may be observed passing in different directions.

There are also ligaments which arise from the cartilages of the seventh rib, and are fixed into the ensiform cartilage.

Ligaments of the Pelvis, called *Sacro-Ischiatic.*

THE principal ligaments not only unite the bones of the pelvis, but also support the viscera of the pelvis, and give origin to muscles.

These ligaments, which are of unequal size, are placed towards the posterior and inferior part of the pelvis.

Those ligaments which are incorporated with the posterior ligaments of the spine, arise from the transverse processes of the os sacrum, and from the upper part of the ossa coccygis.

The larger or posterior, is fixed, by its smaller extremity, into the tuberosity of the os ischium; and *the smaller or anterior*, which is disposed nearly transversely, is fixed into the spine of the os ischium.

There are *two membranous productions* connected to the larger sacro-ischiatic ligament, which have been named the *superior* and *inferior appendices* of it.

The superior appendix arises from the back-part of the spine of the os ilium, and is fixed along the outer edge of the sacro-sciatic ligament.

The inferior appendix is placed within the cavity of the pelvis, and is connected with the middle of the external sacro-ischiatic ligament.

The *obturator ligament* fills up the foramen obturatorium; in this there are apertures for the obturator artery, vein, and nerve.

There are also *longitudinal ligamentous fibres* extending along the os sacrum and ossa coccygis, which serve to bind the several bones intimately to each other.

There is a *capsular ligament* proper to the os coccygis, which serves to unite it to the os sacrum.

Paupart's ligament, or *the crural arch*, has been described by some authors as a ligament of the pelvis. I have described it as the tendon of the external oblique muscle of the abdomen.

The ligaments called *ilio-sacral*, take their rise from the posterior spinous process of the os ilium, and are fixed to the third and fourth spinous transverse processes of the os sacrum.

There are strong *capsular ligaments* which connect the os sacrum to the ossa innominata; and within these joints, there are three *layers of cartilage*, which adhere to the os sacrum upon the joint being opened; and within this joint, there is a yellow-coloured ligamentous substance which contains *mucus*.

The large apertures on the back-part of the os sacrum, are surrounded by *various ligaments*, which extend from one tubercle to another, and which tend to protect the vessels passing beneath them.

The ossa pubis are united *by a capsular ligament*, called the *capsular ligament* of the *symphysis pubis*.

Upon opening this joint, we find, besides the cartilage covering each of the ossa pubis, *an intermediate cartilage*, somewhat like the intervertebral cartilages, consisting of fibres disposed in a transverse direction.

Such was Dr WILLIAM HUNTER'S * description of this joint.

Mr TENON, who has lately published on the subject, has observed, that the ossa pubis are sometimes joined by one cartilage, and sometimes in the manner above described †.

CALDANI has published several very faithful representations of the ligaments of the pelvis, of which there are copies in Dr PARR'S Medical Dictionary.

* Vid. Med. Obs. and Inq. vol. ii. p. 333.

† Vid. Mém. de l'Institut. des Sciences, tom. vi. p. 178.

OF THE EXTREMITIES.

CHAPTER I.

OF THE BONES OF THE SUPERIOR EXTREMITIES.

THE *superior extremities*, consist of the *shoulder*, *arm*, *fore-arm*, and *hand*.

The *shoulder* consists of the *clavicle* and *scapula*.

Of the Clavicle.

The CLAVICULA, or *collar-bone* *, is the long crooked bone, in figure like an Italick *f* placed almost horizontally between the upper lateral part of the sternum, and what is commonly called the *top* of the *shoulder*, which, as a clavis or beam, it bears off from the trunk of the body.

The *clavicle*, as well as other long round bones, is larger at its two ends, than in the middle. The end next to the sternum † is triangular: the angle

* Os jugulare, jugulum, furcula, ligula, clavis, humerus quibusdam.

† Παραστάγις.

behind is considerably produced, to form a sharp ridge, to which the transverse ligament extended from one clavicle to the other is fixed *. The side opposite to this is somewhat rounded.

The middle of this protuberant end, is as irregularly hollowed, as the cavity in the sternum for receiving it, is raised; but in a recent subject, the irregular concavities of both, are supplied by a moveable cartilage, which is not only much more closely connected every where by ligaments to the circumference of the articulation, than those of the lower jaw are; but it grows to the two bones at both its internal and external end: its substance at the internal end being soft, but very strong, and resembling the intervertebral cartilages †.

From this internal end, the clavicle, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and forepart of this curvature, a small ridge is seen, with a plain rough surface before it; whence the musculus sterno-hyoideus and sterno-mastoideus have in part their origin.

Near the lower angle a small plain surface is often to be remarked, where the first rib and this

* Riolan. Encheirid. Anat. lib. vi. cap. 13. Winslow, Expos. Anat. des Os frais. § 248. Weitbrecht. Act. Petropolit. tom. 4. p. 255. & Syndesmolog. sect. 2. I. 3.

† Weitbrecht, Sydesmolog. sect. 2. I. § 6.

bone are contiguous *, and are connected by a firm ligament †.

From this, a rough plain surface is extended outwards, where the pectoral muscle has part of its origin. Behind, the bone is made flat and rough by the insertion of the larger share of the subclavian muscle. After the clavicle begins to be bended backwards, it is round, but soon after becomes broad and thin; which shape it retains to its external end. Along the external concavity, a rough sinuosity runs, from which some part of the deltoid muscle takes its rise: Opposite to this, on the convex edge, a scabrous ridge gives insertion to a share of the cucullaris muscle. The upper surface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the musculus subclavius; and towards its back-part a tubercle rises, to which, and a roughness near it, the strong short ligament connecting this bone to the coracoid process of the scapula is fixed.

The external end‡ of this bone is horizontally oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the acromion scapulæ. Round this, the bone is spongy, for the firmer connexion of the ligaments.

The triangular unequal interior end of each

* Dionis, Sixieme Demonst. des Os.

† Weitbrecht, Syndesmolog. sect. 2. I. § 7.

‡ Ἐπωμὶς.

clavicle, has the cartilage above described, interposed betwixt it and the irregular cavity of the sternum. The ligaments which surround this articulation are short and strong, and admit of little motion any way; and the strong ligament that is stretched across the upper furcula of the sternum, from the posterior prominent angle of the one clavicle, to the same place of the other clavicle, serves to keep each of these bones more firmly in their place. By the assistance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raised or depressed, and moved backwards and forwards so much, as that the external end, which is at a great distance from that axis, enjoys very conspicuous motions. The articulation of the exterior end of the clavicle shall be considered after the description of the scapula.

The clavicles keep the scapulæ, and consequently all the superior extremities, from falling in and forward upon the thorax; by which, as in most quadrupeds, the motions of the arms would be much confined, and the breast made too narrow. The clavicles likewise afford origin to several muscles, and a defence to large vessels.

From the situation, figure and use of the clavicles, it is evident, that they are much exposed to fractures; that their broken parts must generally cross each other, and that they are difficultly kept in their place afterwards.

Of the Scapula.

THE SCAPULA, or shoulder-blade, is the triangular bone situated on the outside of the ribs, with its longest side, called its base, towards the spinal processes of the vertebræ, and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance from these processes. The back-part of the scapula has nothing but the thin ends of the serratus anticus major, and subscapularis muscles between it and the ribs: But as this bone advances forwards, its distance from the ribs increases. The upper or shortest side, called the *superior costa* of the scapula, is nearly horizontal, and parallel with the second rib. The lower side, which is named the *inferior costa*, is extended obliquely from the third to the eighth rib. The situation of this bone, here described, is when people are sitting or standing in a state of inactivity, and allowing the members to remain in the most natural easy posture. The inferior angle of the scapula is very acute; the upper one is near to a right angle; and what is called the anterior, does not deserve the name, for the two sides do not meet to form an angle. The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorsum*. Three processes are generally reckoned to proceed from the scapula. The first is the large spine that rises from its convex

surface behind, and divides it unequally. The second process stands out from the fore-part of the upper side; and, from its imaginary resemblance to a crow's beak, is named *coracoides* *. The third process is the whole thick bulbous fore-part of the bone.

After thus naming the several constituent parts of the scapula, the particular description will be more easily understood.

The base, which is tipped with cartilage in a young subject, is not all straight: For above the spine, it runs obliquely forwards to the superior angle; that here it might not be too protuberant backwards, and so bruise the muscles and teguments: Into the oblique space, the musculus patientiæ is inserted. At the root of the spine, on the back-part of the base, a triangular plain surface is formed, by the pressure of the lower fibres of the trapezius. Below this the edge of the scapula is scabrous and rough, for the insertion of the serratus major anticus and rhomboid muscles.

The back-part of the inferior angle is made smooth by the latissimus dorsi passing over it. This muscle also alters the direction of the inferior costa some way forwards from this angle; and so far it is flatted behind by the origin of the teres major. As the inferior costa advances forward, it is of considerable thickness, is slightly hollowed, and made smooth behind by the teres minor, while it has a fossa formed into it below,

* Anchoroides, sigmoides, digitalis ancistroides.

by part of the subscapularis; and between the two a ridge with a small depression appears, where the longus extensor cubiti has its origin.

The superior costa is very thin; and near its fore-part there is a semilunar nitch, from one end of which to the other, a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes for the passage of the scapular blood-vessels and nerves. Immediately behind this semilunar cavity, the coraco-hyoid muscle has its rise. From the nitch to the termination of the fossa for the teres-minor, the scapula is narrower than any where else, and supports the third process. This part has the name of cervix.

The whole dorsum of the scapula is divided into two cavities by the spine, which is stretched from behind forwards, much nearer to the superior than to the inferior costa.

The cavity above the spine is really concave, where the supra-spinatus muscle is lodged; while the surface of this bone below the spine, on which the infra-spinatus muscle is placed, is convex, except a fossa that runs at the side of the inferior costa.

The internal or anterior surface of this bone is hollow, except in the part above the spine, which is convex. The subscapularis muscle is extended over this surface, where it forms several ridges and intermediate depressions, commonly mistaken for prints of the ribs; they point out the inter-

stices of the bundles of fibres of which the subscapularis muscle is composed *.

The spine † rises small at the base of the scapula, and becomes higher and broader as it advances forwards. On the sides it is unequally hollowed and crooked, by the actions of the adjacent muscles. Its ridge ‡ is divided into two rough flat surfaces: Into the upper one, the trapezius muscle is inserted; and the lower one has part of the deltoid fixed to it. The end of the spine, called *acromion*, or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage §. The anterior edge of the acromion is flat, smooth, and covered with a cartilage, for its articulation with the external end of the clavicle; and it is hollowed below, to allow a passage to the infra and supra spinati muscles, and free motion to the os humeri.

The coracoid process is crooked, with its point inclining forwards; so that a hollow is left at the lower side of its root, for the passage of the infrascapularis muscle. The end of this process is marked with three plain surfaces. Into the internal, the serratus minor anticus is inserted: From the external, one head of the biceps flexor cubiti

* Winslow, in Memoires de l'Acad. des Sciences, 1722.

† Ραχις, ὑπερόχη ὠμοπλατῶν, eminentia scapularum.

‡ Pterigium, crista.

§ Sue, Trad. d'Osteol. p. 160.

rises; and from the lower one, the coracobrachialis has its origin. At the upper part of the root of this process, immediately before the semilunar cavity, a smooth tubercle appears, where a ligament from the clavicle is fixed. From all the external side of this coracoid apophyse, a broad ligament goes out, which becomes narrower where it is fixed to the acromion. The sharp pain, violent inflammation, and tedious cure of contusions in this part, are probably owing to these tendons and ligaments being hurt.

From the cervix scapulæ the third process is produced. The fore-part of this is formed into a glenoid cavity *, which is of the shape of the longitudinal section of an egg, being broad below, and narrow above. Between the brims of this hollow and the fore-part of the root of the spine, a large sinuosity is left, for the transmission of the supra and infra spinati muscles; and on the upper part of these brims we may remark a smooth surface, where the second head of the biceps flexor cubiti has its origin. The root of the supercilia is rough all round, for the firmer adhesion of the capsular ligament of the articulation, and of the cartilage which is placed on these brims, where it is thick, but becomes very thin as it is continued towards the middle of the cavity, which it lines all over.

* Ωμοκότυλις.

The medullary vessels enter the scapula near the base of the spine.

The substance of the scapula, as in all other broad flat bones, is cellular, but of an unequal thickness; for the neck and third process are thick and strong. The inferior costa, spine, and coracoid process, are of a middle thickness; and the body is so pressed by the muscles, as to become thin and diaphanous.

The scapula and clavicle are joined by plain surfaces, tipped with cartilage; by which neither bone is allowed any considerable motion, being tightly tied down by the common capsular ligament, and by a very strong one which proceeds from the coracoid process; but divides into two before it is fixed into the clavicle, with such a direction, as either can allow this bone to have a small rotation, in which its posterior edge turns more backwards, while the anterior one rises farther forwards; or it can yield to the fore-part of the scapula moving downwards, while the back-part of it is drawn upwards; in both which cases the oblong smooth articulated surfaces of the clavicle and scapula are not in the same plane, but stand a little transversely, or across each other, and thereby preserve this joint from luxations, to which it would be subject, if either of the bones was to move on the other perpendicularly up and down, without any rotation. Sometimes a moveable ligamentous cartilage is found in this joint; in other cases a cartilage is only interposed at the

anterior half of it; and in some old subjects I have found a sesamoid bone here *. The scapula is connected to the *head*, *os hyoides*, *vertebræ*, *ribs*, and *arm-bone*, by muscles, that have one end fastened to these bones, and the other to the scapula, which can move it upwards, downwards, backwards, or forwards; by the quick succession of these motions, its whole body is carried in a circle. But being also often moved, as upon an axis perpendicular to its plane, its circumference turns in a circle, whose centre this axis is †. Whichever of these motions it performs, it always carries the outer end of the clavicle and the arm along with it. The glenoid cavity of this bone receives the *os humeri*, which plays in it as a ball in a socket, as will be explained more hereafter.

The scapula serves as a *fulcrum* to the arm; and, by altering its position on different occasions, allows always the head of the os humeri a right situated socket to move in; and thereby extends the sphere of motion of the superior extremity, and affords the muscles which rise from it more advantageous actions, by altering their directions to the bone which they are to move. This bone also serves to defend the back-part of the thorax, and is often employed to sustain weights, or to resist forces, too great for the arm to bear.

* Jac. Sylv. Isagog. Anat. lib. 1. cap. 2.

† See Winslow, Memoires de l'Acad. des Sciences, 1726.

The *base, acromion, coracoid process,* and *head* of the *scapula,* are all in a cartilaginous state at birth; and the three first are joined as epiphyses; while the head, with the glenoid cavity, is not formed into a distinct separate bone, but is gradually produced by the ossification of the body of this bone being continued forwards.

Of the Os Humeri.

The ARM has only one bone, called *os humeri*; which is long, round, and nearly straight.

At the upper end of this bone there is a large round smooth head, whose middle point is not in a straight line with the axis of the bone, but stands obliquely backwards from it, and it is bounded by a circular fossa, into which the capsular ligament of the joint is fixed. Below the fore-part of its base, two tubercles stand out: The smaller, which is situated most to the inside *, has the tendon of the *subscapularis* muscle inserted into it. The larger more external protuberance is divided, at its upper part, into three smooth plain surfaces: Into the anterior of which, the *musculus supra-spinatus;* into the middle or largest, the *infra-spinatus;* into the one behind,

* The humerus is supposed to be viewed in the pendulous position with the palm of the hand directed forwards.

In this position, those parts that look towards the radius, are external; those towards the ulna internal; those towards the palm anterior; and those towards the elbow posterior.

the *teres minor*, is inserted. Between these two tubercles, exactly in the fore-part of the bone, a deep long fossa is formed, for lodging the tendinous head of the *biceps flexor cubiti;* which, after passing, in a manner peculiar to itself, through the cavity of the articulation, is tied down by a tendinous sheath extended across the fossa; in which, and in the neighbouring tubercles, are several remarkable holes, which are penetrated by the tendinous and ligamentous fibres, and by vessels. On each side of this fossa as it descends in the os humeri, a rough ridge, gently flatted in the middle, runs from the roots of the tubercles. The tendon of the pectoral muscle is fixed into the anterior of these ridges, and the *latissimus dorsi*, and *teres major*, are inserted into the internal one. A little behind the lower end of this last, another rough ridge may be observed, where the *coracobrachialis* is inserted. From the back-part of the root of the largest tubercle, a ridge also is continued, from which the brevis extensor cubiti rises. This bone is flatted on the inside, about its middle, by the belly of the biceps flexor cubiti. In the middle of this plain surface, the entry of the medullary artery is seen slanting obliquely downwards. At the fore-side of this plane, the bone rises in a sort of ridge, which is rough, and often has a great many small holes in it, where the tendon of the strong deltoid muscle is inserted; on each side of which, the bone is smooth and flat, where the brachiæus internus rises. The exterior

of these two flat surfaces is the larger; behind it a superficial spiral channel, formed by the muscular nerve and the vessels that accompany it, runs from behind, forwards, and downwards. The body of the os humeri is flatted behind by the extensors of the form-arm. Near the lower end of this bone, a large sharp ridge is extended on its out-side, from which the musculus supinator radii longus, and the longest head of the extensor carpi radialis rise. Opposite to this, there is another small ridge to which the aponeurotic tendon, that gives origin to the fibres of the internal and external brachiæi muscles is fixed; and from a little depression on the fore-side of it, the pronator radii teres rises.

The body of the os humeri becomes gradually broader towards the lower end, where it has several processes; at the roots of which, there is a cavity before, and another behind *.

The anterior is divided by a ridge into two; the external, which is the least, receives the end of the radius; and the internal receives the coronoid process of the ulna in the flexions of the fore-arm, while the posterior deep triangular cavity lodges the olecranon in the extensions of that member.

The bone betwixt these two cavities is pressed so thin by the processes of the ulna, as to appear diaphanous in several subjects.

The sides of the posterior cavity are stretched

* Βαθμοειδεις.

out into two processes, one on each side: These are called *condyles;* from each of which a strong ligament goes out to the bones of the fore-arm. The external condyle, which has an oblique direction also forwards in respect of the internal, when the arm is in the most natural posture *, is equally broad, and has an obtuse smooth head rising from it forwards.

From the rough part of the condyle, the inferior head of the bicornis †, the extensor digitorum communis, extensor carpi ulnaris ‡ anconæus, and some part of the supinator radii brevis, take their rise; and on the smooth head the upper end of the radius plays. Immediately on the outside of this, there is a sinuosity made by the shorter head of the bicornis muscle, upon which the muscular nerve is placed.

The internal condyle is more pointed and protuberant than the external, to give origin to some part of the flexor carpi radialis §, pronator radii teres, palmaris longus, flexor digitorum sublimus, and flexor carpi ulnaris ‖. Between the two condyles, is the trochlea or pully, which consists of two lateral protuberances, and a middle cavity, that are smooth and covered with cartilage.

* Winslow, Memoires de l'Acad. des Sciences, 1722.

† Radialis externus. Alb.

‡ Ulnaris externus. Alb.

§ Radialis internus. Alb.

‖ Ulnaris internus. Alb.

When the fore-arm is extended, the tendon of the internal brachiæus muscle is lodged in the fore-part of the cavity of this pully. The external protuberance, which is less than the other, has a sharp edge behind; but forwards, this ridge is obtuse, and separated from the little head, already described, only by a small fossa, in which the joined edges of the ulna and radius move.

The internal protuberance of the pully is larger and higher; and therefore in the motions of the ulna upon it, that bone would be inclined outwards, was it not supported by the radius on that side.

Between this internal protuberance and condyle, a sinuosity may be remarked, where the ulnar nerve passes.

The substance and the internal structure of the os humeri is the same, and disposed in the same way as in other long bones.

The round head at the upper end of this bone is articulated with the glenoid cavity of the scapula; which being superficial, and having long ligaments, allows the arm a free and extensive motion. These ligaments are however considerably strong. For, besides the common capsular one, the tendons of the muscles perform the office, and have been described under the name of *ligaments*. Then the acromion and coracoid process, with the strong broad ligaments stretched betwixt them, secure the articulation above, where the greatest

and most frequent force is applied to thrust the head of the bone out of its place. It is true that there is not nearly so strong a defence at the lower part of the articulation; but in the ordinary postures of the arm, that is, so long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occasion a luxation, since the joint is protected so well above.

The motions which the arm enjoys by this articulation, are to every side; and by the succession of these different motions, a circle may be described. Besides which, the bone performs a considerable rotation round its own axis. But though this can be performed with the round head in all positions; yet as these vary, the effects upon the body of the bone are very different: For, if the middle of the head is the centre of rotation, as it is when the arm hangs down by the side, the body of the bone is moved only forwards and backwards; because the axis of motion of the head is nearly at right angles with the length of the bone *; whereas, when the arm is raised to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the same straight line; and therefore the body of the os humeri performs the same motion with its head.—Though the motions of the arm seem to be very extensive, yet a large share of them

* HIPPOCRAT. de articul. § 1.

depends on the motion of the scapula. The lower end of the os humeri is articulated with the bones of the fore-arm, and carries them with it in all its motions, but serves as a base on which they perform the motions peculiar to themselves.

Both the ends of this bone are cartilaginous in a new-born infant, and the large head with the two tubercles, and the trochlea with the two condyles, become epiphyses before they are united to the body of the bone.

Of the Fore-Arm.

The FORE-ARM * consists of two long bones, the Ulna and Radius; whose situation, in respect of each other, is oblique in the least straining or most natural posture; that is, the ulna is not directly behind, nor on the outside of the radius, but in a middle situation between these two, and the radius crosses it. The fore-arm is proportionally longer in the African, than in the European.

In the subsequent account of the superior extremity, I understand by the term of *posterior*, that part which is in the same direction with the back of the hand; by anterior, that answering to the palm; by internal, that on the same side with the thumb; by external, the side nearest to the little

* Cubitus, πηχυς, ωλεν̓η, πυγών, ulna, lacertus.

finger; supposing the hand always to be in a middle position between pronation and supination.

Of the Ulna.

The ULNA *, so named from its being used as a measure, is the longest of the two bones of the fore-arm, and situated on the outside of the radius.

At the upper end of the ulna are two processes.—The posterior is the larger, and formed like a hook, whose concave surface moves upon the pully of the os humeri, and is called *olecranon* †, or top of the cubit. The convex back-part of it is rough and scabrous, where the longus, brevis, and brachiæus externus, are inserted.

The olecranon makes it unnecessary that the tendons of the extensor muscles should pass over the end of the os humeri; which would have been of ill consequence in the great flexions of this joint, or when any considerable external force is applied to this part ‡. The anterior process is not so large, nor does it reach so high as the one be-

* Cubitus, πηχυς, προπηχυον, focile majus, canna vel arundo major, et inferior brachii.

† Αγκων, gibber cubitus, additamentum necatum.

‡ WINSLOW, Exposition anatomique du corps humain, traité des os secs, § 979.

hind; but is sharper at its end, and therefore is named *coronoid.*

Between these two processes, a large semicircular or sigmoid concavity is left; the surface of which, on each side of a middle rising, is slanting, and exactly adapted to the pully of the bone of the arm.

Across the middle of it, there is a small sinuosity, where, as well as in a small hollow on the internal side of it, the cartilage that lines the rest of its surface is wanting.

Round the brims of this concavity the bone is rough, where the capsular ligament of the joint is implanted.

Immediately below the olecranon, on the back-part of the ulna, a flat triangular spongy surface appears, on which we commonly lean.

At the internal side of this, there is a larger hollow surface, where the musculus anconæus is lodged; and the ridge at the inside of this gives rise to the musculus supinator radii brevis.

Between the top of the ridge and the coronoid process, is the semilunated smooth cavity, lined with cartilage, in which, and a ligament extended from the one to the other end of this cavity, the round head of the radius plays. Immediately below it a rough hollow gives lodging to mucilaginous glands.

Below the root of the coronoid process, this bone is scabrous and unequal, where the brachiæus internus is inserted.

On the outside of that we observe a smooth concavity, where the flexor digitorum profundus takes its origin.

The body of the ulna is triangular.

The internal angle is very sharp where the ligament that connects the two bones is fixed: The sides which make this angle, are flat and rough, by the action and adhesion of the many muscles which are situated here.

At the distance of one third of the length of the ulna from the top, in its fore-part, the passage of the medullary vessels is to be remarked slanting upwards.

The external side of this bone is smooth, somewhat convex, and the angles at each edge of it are blunted by the pressure of the muscles equally disposed about them.

As this bone descends, it becomes gradually smaller; so that its lower end terminates in a little head, standing on a small neck.

Towards the fore but outer part of which last, an oblique ridge runs, that gives rise to the pronator radii quadratus.

The head is round, smooth, and covered with a cartilage on its internal side, to be received into the semilunar cavity of the radius; while a styloid process* rises from its outside, to which is fixed a strong ligament that is extended to the os cuneiforme and pisiforme of the wrist.

* παραπηχυς, malleolus externus.

Between the back-part of that internal smooth side and this process, a sinuosity is left for the tendon of the extensor carpi ulnaris. On the fore-part of the root of the process, such another depression may be remarked for the passage of the ulnar artery and nerve.

The end of the bone is smooth, and covered with a cartilage.

Between it and the bones of the wrist, a doubly concave moveable cartilage is interposed; which is a continuation of the cartilage that covers the lower end of the radius, and is connected loosely to the root of the styloid process, and to the rough cavity there, in which mucilaginous glands are lodged.

The ulna is articulated above with the lower end of the os humeri, where these bones have depressions and protuberances corresponding to each other, so as to allow an easy and secure extension of the fore-arm to almost a straight line with the arm, and flexion to a very acute angle; but, by the slanting position of the pully, the lower part of the fore-arm is turned outwards in the extension, and inwards in the flexion*; and a very small kind of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed by the fore-arm being in a middle degree of flexion. The ulna is also articulated with the radius and carpus, in a manner to be related afterwards.

* Winslow, Memoires de l'Acad. des Sciences, 1722.

Of the Radius.

The RADIUS *, so called from its imagined resemblance to a spoke of a wheel, is the bone placed at the inside of the fore-arm.

Its upper end is formed into a circular little head, which is hollowed for its articulation with the tubercle at the side of the pully of the os humeri; and the half of the round circumference of the head next to the ulna is smooth, and covered with a cartilage, in order to be received into the semilunated cavity of that bone.

Below the head, the radius is much smaller; therefore this part is named its *cervix*, which is made round by the action of the supinator radii brevis.

At the external root of this neck, a tuberous process rises; into the outer part of which the biceps flexor cubiti is inserted. From this, a ridge runs downwards and inwards, where the supinator radii brevis is inserted; and a little below, and behind this ridge, there is a rough scabrous surface, where the pronator radii teres is fixed.

The body of the radius is not straight, but convex on its internal and posterior surfaces; where it is also made round by the equal pressure of the circumjacent muscles, particularly of the extensors of the thumb; but the surfaces next to the ulna are flatted and rough, for the origins of the

* Κερκις, παραπηχιον, focile minus, canna minor, arundo minor.

muscles of the hand; and both terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed.

A little below the beginning of the plain surface, on its fore-part, where the flexor muscle of the last joint of the thumb takes its origin, the passage of the medullary vessels is seen slanting upwards. The radius becomes broader and flatter towards the lower end, especially on its fore-part, where its pronator quadratus muscle is situated.

The lower end of the radius is larger than the superior; though not in such a disproportion as the upper end of the ulna is larger than its lower end.

Its back-part has a flat strong ridge in the middle, and fossæ on each side.

In a small groove immediately on the outside of the ridge, the tendon of the extensor tertii internodii pollicis plays.

In a large one beyond this, the tendons of the indicator and of the common extensor muscles of the fingers pass.

Contiguous to the ulna, there is a small depression made by the extensor minimi digiti.

On the inside of the ridge, there is a broad depression, which seems again subdivided, where the two tendons of the bicornis, or extensor carpi radialis are lodged.

The internal side of this end of the radius is also hollowed by the extensors of the first and se-

cond joint of the thumb; immediately above which, a little rough surface shews where the supinator radii longus is inserted.

The ridges at the sides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the several sheaths for the tendons are formed. The fore-part of this end of the radius is also depressed, where the flexors of the fingers and flexor carpi radialis pass.

The external side is formed into a semilunated smooth cavity, lined with a cartilage, for receiving the lower end of the ulna.

The lowest part of the radius is formed into an oblong cavity; in the middle of which is a small transverse rising, gently hollowed; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.

The internal side of this articulation is fenced by a remarkable process * of the radius, from which a ligament goes out to the wrist, as the styloid process of the ulna with its ligament guards it on the outside.

The ends of both of the bones of the fore-arm being thicker than the middle, there is a considerable distance between the bodies of these bones; in the larger part of which a strong tendinous, but thin ligament is extended, to give a large enough surface for the origin of the numerous

* Malleolus internus, processus styloides.

fibres of the muscles situated here, that are so much sunk between the bones, as to be protected from injuries, to which they would otherwise be exposed. But this ligament is wanting near the upper end of the fore-arm, where the supinator radii brevis, and flexor digitorum profundus, are immediately connected *.

Both ends of the bones of the fore-arm are first cartilages, and then epiphyses in children.

As the head of the radius receives the tubercle of the os humeri, it is not only bended and extended along with the ulna, but may be moved round its axis in any position; and that this motion round its axis may be sufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.

This bone is also joined to the ulna by a double articulation; for above, a tubercle of the radius plays in a socket of the ulna; whilst below, the radius gives the socket, and the ulna the tubercle: But then the motion performed in these two is very different; for at the upper end, the radius does no more than turn round its axis; while at the lower end, it moves in a sort of cycloid upon the round part of the ulna; and as the hand is articulated and firmly connected here with the radius, they must move together.

* Weitbrecht, Syndesmolog. fig. 10, 11.

When the palm is turned uppermost, the radius is said to perform the supination; when the back of the hand is above, it is said to be prone. But then the quickness and large extent of these two motions are assisted by the ulna, which, as was before observed, can move with a kind of small rotation on the sloping sides of the pully. This lateral motion, though very inconsiderable in the joint itself, is conspicuous at the lower end of such a long bone; and the strong ligament connecting this lower end to the carpus, makes the hand more readily obey these motions. When we design a large circular turn of our hand, we increase it by the rotation of the os humeri, and sometimes employ the spine and inferior extremities to make these motions of pronation or supination of the hand large enough.

Of the Hand.

The HAND* comprehends all from the joint of the wrist to the point of the fingers. Its back-part is convex, for greater firmness and strength; and it is concave before, for containing more surely and conveniently such bodies as we take hold of.

One half of the hand has an obscure motion in comparison of what the other has, and serves as a base to the moveable half; which can be extend-

* Ακρόχειρ, summa manus.

ed back very little farther than to a straight line with the fore-arm, but can be considerably bended forwards.

The hand has commonly been divided into the *carpus*, *metacarpus*, and *fingers*; among which last the thumb is reckoned.

The CARPUS * is composed of eight small spongy bones, situated at the upper part of the hand. I shall describe each of these bones, under a proper name taken from their figure †. I shall begin with the range of bones that are concerned in the moveable joint of the wrist, or are connected to the fore-arm, and shall afterwards consider the four that support the thumb and ossa metacarpi of the fingers.

The eight bones of the carpus are, *os scaphoides*, *lunare*, *cuneiforme*, *pisiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *scaphoides* is situated most internally of those that are articulated with the fore-arm.

The *lunare* is immediately on the outside of the former.

The *cuneiforme* is placed still more externally, but does not reach so high up as the other two.

The *pisiforme* stands forwards into the palm from the cuneiforme.

The *trapezium* is the first of the second row, and is situated betwixt the scaphoides and first joint of the thumb.

* Καρπος, brachiale, prima palmæ pars, rasetta.

† Lyser. Cult. Anat. lib. 5. cap. 2.

The *trapezoides* is immediately on the outside of the trapezium.

The *os magnum* is still more external.

The *unciforme* is farther to the side of the little finger.

Of the Os Scaphoides.

The Os Scaphoides * is the largest of the eight except one. It is convex above, concave and oblong below; and bears a distant resemblance to a boat; hence its name. Its smooth convex surface is divided by a rough middle fossa, which runs obliquely cross it. The upper largest division is articulated with the radius. Into the fossa the common ligament of the joint of the wrist is fixed; and the lower division is joined to the trapezium and trapezoides. The concavity receives more than an half of the round head of the os magnum. The external side of this hollow is formed into a semilunar plane, to be articulated with the following bone. The internal, posterior, and anterior edges are rough, for fixing the ligaments that connect it to the surrounding bones.

Of the Os Lunare.

The Os Lunare † has a smooth convex upper surface, by which it is articulated with the radius.

* Κατυλοειδὲς, naviculare.

† Lunatum.

The internal side, which gives the name to the bone, is in the form of a crescent, and is joined with the scaphoid; the lower surface is hollow, for receiving part of the head of the os magnum.

On the outside of this cavity is another smooth, but narrow oblong sinuosity, for receiving the upper end of the os unciforme. On the outside of which a small round convexity is found, for its connexion with the os cuneiforme. Between the great convexity above, and the first deep inferior cavity, there is a rough fossa, in which the circular ligament of the joint of the wrist is fixed.

Of the Os Cuneiforme.

The Os Cuneiforme * is broader above, and towards the back of the hand, than it is below and forwards: which gives it the resemblance of a wedge. The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the ulna. Below this the cuneiforme bone has a rough fossa, wherein the ligament of the articulation of the wrist is fixed. On the internal side of this bone, where it is contiguous to the os lunare, it is smooth and slightly concave.

Its lower surface, where it is contiguous to the os unciforme, is oblong, somewhat spiral, and concave.

* Triquetrum.

Near the middle of its anterior surface a circular plane appears, where the os pisiforme is sustained.

Of the Os Pisiforme.

The Os Pisiforme * is almost spherical, except one circular plane, or slightly hollow surface, which is covered with cartilage for its motion on the cuneiform bone, from which its whole rough body is prominent forwards into the palm; having the tendon of the flexor carpi ulnaris, and a ligament from the styloid process of the ulna, fixed to its upper part; the transverse ligament of the wrist is connected to its internal side; ligaments extended to the unciforme bone, and to the os metacarpi of the little finger, are attached to its lower part; the abductor minimi digiti has its orgin from its fore-part; and, at the internal side of it, a small depression is formed, for the passage of the ulnar nerve.

Of the Trapezium.

The Trapezium † has four unequal sides and angles in its back-part, from which it has got it

* Cartilaginosum, subrotundum, rectum.

† Os cubiforme, trapezoides, multangulum majus.

name. Above, its surface is smooth, slightly hollowed, and semicircular, for its conjunction with the os scaphoides. Its external side is an oblong concave square, for receiving the following bone.

The inferior surface is formed into a pulley; the two protuberant sides of which are external and internal. On this pulley the first bone of the thumb is moved.

At the external side of the external protuberance, a small oblong smooth surface is formed by the os metacarpi indicis.

The fore-part of the trapezium is prominent in the palm, and, near to the external side, has a sinuosity in it, where the tendon of the flexor carpi radialis is lodged; on the ligamentous sheath of which the tendon of the flexor tertii internodii pollicis plays: And still more externally the bone is scabrous, where the transverse ligament of the wrist is connected, the abductor and flexor primi internodii pollicis have their origin, and ligaments go out to the first bone of the thumb.

Of the Os Trapezoides.

The Os TRAPEZOIDES *, so called from the irregular quadrangular figure of its back-part, is the smallest bone of the wrist, except the pisiforme.

The figure of it is an irregular cube.

* Trapezium, multangulum minus.

It has a small hollow surface above, by which it joins the scaphoides; a long convex one internally, where it is contiguous to the trapezium; a small external one, for its conjunction with the os magnum; and an inferior convex surface, the edges of which are however so raised before and behind, that a sort of pulley is formed, where it sustains the os mètacarpi indicis.

Of the Os Magnum.

The Os Magnum * so called because it is the largest bone of the carpus, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain one below.

The round head is divided by a small rising, opposite to the connexion of the os scaphoides and lunare, which together form the cavity for receiving it. On the inside, a short plain surface joins the os magnum to the trapezoides.

On the outside is a long narrow concave surface, where it is contiguous to the os unciforme.

The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and farther advanced on the internal side than on the external, having a considerable oblong depression made on the advanced inside by the metacarpal bone of the fore-finger; and gene-

* Maximum, capitatum.

rally there is a small mark of the os mètacarpi digiti annularis on its external side.

Of the Os Unciforme.

The Os Unciforme * has got its name from a thin broad process that stands out from it forwards into the palm, and is hollow on its inside, for affording passage to the tendons of the flexors of the fingers. To this process also the transverse ligament is fixed, that binds down and defends these tendons; and the flexor and abductor muscles of the little finger have part of their origin from it.

The upper plain surface is small, convex, and joined with the os lunare.

The internal side is long, and slightly convex, adapted to the contiguous os magnum.

The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone.

The lower end is divided into two concave surfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

In the description of the preceding eight bones, I have mentioned only those plain surfaces covered with cartilage, by which they are articulated to each other, or to some other bones, except in

* Cuneiforme.

some few cases, where something extraordinary was to be observed; and I have designedly omitted the other rough surfaces, lest, by crowding too many words in the description of such small bones, the whole should be unintelligible: But these scabrous part of the bones may easily be understood, after mentioning their figure, if it is observed, that they are generally found only towards the back or palm of the hand; that they are all plain, larger behind than before; and that they receive the different ligaments, by which they are either connected to neighbouring bones, or to one another; for these ligaments cover all the bones, and are so accurately applied to them, that, at first view, the whole carpus of a recent subject appears one smooth bone *.

As the surfaces of these bones are larger behind, the figure of the whole conjoined must be convex there, and concave before; which concavity is still more increased by the os pisiforme, and process of the os unciforme, standing forwards on one side, as the trapezium does on the other: And the bones are securely kept in this form, by the broad strong transverse ligament connected to these parts of them that stand prominent into the palm of the hand. The convexity behind renders the whole fabric stronger, where it is most exposed to injuries; and the large anterior hollow is

* Galen de usu part. lib. 2. cap. 8. For a particular description of these ligaments, see WEITBRECHT. Syndesmolog. p. 5.—68.

necessary for a safe passage to the numerous vessels, nerves, and tendons of the fingers.

The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the forearm; so as to allow motion to all sides, and, by a quick succession of these motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed to the carpus round its axis, except what it has in the pronation and supination along with the radius.

The articulation of the first three bones of the superior row, with the bones of the inferior, is such as allows of motion, especially backwards and forwards; to the security and easiness of which the reception of the os magnum into the cavity formed by the scaphoides and lunare contributes considerably: And the greater number of the muscles that serve for the motion of the wrist on the radius, being inserted beyond the conjunction of the first row of bones with the second, act equally on this articulation as they do on the former; and the joint formed with the radius being the most equally moved, the first effect of these muscles is on it; and the second row of the carpus is only moved afterwards. Thus the motion of the wrist is greater than otherwise it could have had safely: For, if as large motion had

been given to one joint, the angle of flexion would have been very acute, and the ligaments must have been longer than was consistent with the firmness and security of the joint.

The surfaces of articulation of the other bones are plain, and scarcely allow of any more motion, because of the strong connecting ligaments, than to yield a little, and so elude the force of any external power; and to render the back of the wrist a little more flat, or the palm more hollow, on proper occasions.

The carpus serves as a base to the hand, protects its tendons, and affords a free large motion.

All the bones of the carpus are in a cartilaginous state at the time of birth.

On account of the many tendons that pass upon the lower end of the fore-arm and the carpus, and of the numerous ligaments of these tendons and of the bones, which are lubricated by synovia; the pain of sprains here is acute, the parts take long time to recover their tone, and their swellings are very obstinate.

Of the Metacarpus.

The METACARPUS * consists of four bones which sustain the fingers. Each bone is long and round, with its ends larger than its body.

The upper end, which some call the base, is

* Κτεὶς πρόσθιον, σῆθος, ἀνθηρὸν, κτένιον, postbrachiale, pectus, palma pecten.

flat and oblong, without any considerable head or cavity; but it is however somewhat hollowed, for the articulation with the carpus: It is made flat and smooth on the sides where these bones are contiguous to each other.

Their bodies are flatted on their back-part by the tendons of the extensors of the fingers.

The anterior surface of these bodies is a little concave, especially in their middle; along which a sharp ridge stands out, which separates the musculi interossei placed on each side of these bones which are there made flat and plain by these muscles.

Their lower ends are raised into large oblong smooth heads, whose greatest extent is forwards from the axis of the bone.

At the fore-part of each side of the root of each of these heads, one or two tubercles stand out, for fixing the ligaments that go from one metacarpal bone to another, to preserve them from being drawn asunder.

Round the heads, a rough ring may be remarked, for the capsular ligaments of the first joints of the fingers to be fixed to; and both sides of these heads are flat, where they press on each other.

The substance of the metacarpal bones is the same with that of all long bones.

At the time of birth, these bones are cartilaginous at both ends, which afterwards become epiphyses.

The metacarpal bones are joined above to the ossa carpi, and to each other by nearly plain surfaces. The movements of these bones are therefore limited. The articulation of their round heads at the lower ends with the cavities of the first bones of the fingers, is to be taken notice of hereafter.

The metacarpal bones are concave towards the palm of the hand, and their basis form the arch of the carpus.

The spaces between them lodge muscles, and their small motion makes them fit supporters for the fingers to play on.

The ossa metacarpi may be distinguished from each other by the following marks.

The os metacarpi indicis is generally the longest. Its base, which is articulated with the os trapezoides, is hollow in the middle.

The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the trapezium.

The exterior ridge is also smooth, and flat on its outside, for its conjunction with the os magnum; immediately below which a semicircular smooth flat surface shews the articulation of this to the second metacarpal bone.

The back-part of this base is flatted, where the long head of the extensor carpi radialis * is inserted; and its fore-part is prominent, where the tendon of the flexor carpi radialis † is fixed.

* Radialis externus. Alb.

† Radialis internus. Alb.

The external side of the body of this bone is more hollowed by the action of muscles, than the internal.

The tubercle at the internal root of its head is larger than the external.

Its base is so firmly fixed to the bone it is connected with, that it has no motion.

The Os metacarpi medii digiti is generally the second in length; but often it is as long as the former; sometimes it is longer; and frequently it appears to equal the first only by the os magnum being farther advanced downwards than any other bone of the wrist.

Its base is a broad superficial cavity, slanting outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process. The internal side of this base is made plain in the same way as the external side of the former bone, while its external side has two hollow circular surfaces, for joining the third metacarpal bone, and between these surfaces there is a rough fossa, for the adhesion of a ligament, and lodging mucilaginous glands. The shorter head of the bicornis is inserted into the back-part of this base. The two sides of this bone are almost equally flatted; only the ridge on the fore-part of the body inclines outwards. The tubercles at the fore-part of the root of the head are equal. The motion of this bone is very little more than the first metacarpal one has; and therefore these two firm-

ly resist bodies pressed against them by the thumb, or fingers, or both.

The Os metacarpi digiti annularis is shorter than the second metacarpal bone. Its base is semicircular and convex, for its conjunction with the os unciforme. On its internal side are two smooth convexities, and a middle fossa, adapted to the second metacarpal bone. The external side has a triangular smooth concave surface to join it with the fourth one. The anterior ridge of its body is situated more to the out than to the inside. The tubercles near the head are equal. The motion of this third metacarpal bone is greater than the motion of the second.

The Os metacarpi minimi digiti is the smallest and sharpest. Its base is irregularly convex, and rises slanting outwards. Its internal side is exactly adapted to the third metacarpal bone. The external has no smooth surface, because it is not contiguous to any other bone; but it is prominent where the extensor carpi ulnaris is inserted. As this metacarpal bone is furnished with a proper moving muscle, has the plainest articulation, is most loosely connected and least confined, it not only enjoys a much larger motion than any of the rest, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb opposite to it.

There are two bones in the thumb, and three in each of the fingers.

Of the Thumb.

The THUMB* is situated obliquely in respect of the fingers, neither directly opposite to them, nor in the same plane with them. Its bones are much thicker and stronger in proportion to their length, than the bones of the fingers are: Which was extremely necessary, since the thumb counteracts all the fingers.

The *first bone*† of the thumb has its base adapted to the double pulley of the *trapezium:* For, in viewing it from one side to the other, it appears convex in the middle; but when considered from behind forwards, it is concave there. The edge at the fore-part of this base is produced farther than any other part; and round the back-part of the base, a rough fossa may be seen, for the connexion of the ligaments of this joint. The body and head of this bone are of the same shape as the ossa metacarpi; only that the body is shorter, and the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: For though it has protuberances and depressions adapted to the double pulley of the trapezium; yet it enjoys a circular motion,

* Αντίχειρ δικονδυλός, magnus digitus, promanus.

† Primum internodium, or metacarpal bone of the thumb. Alior.

as the joints do where a round head of one bone plays in the orbicular socket of another; only it is somewhat more confined and less expeditious, but stronger and more secure, than such joints generally are.

This bone of children is in the same state with the metacarpal bones.

The second bone of the thumb is somewhat like the third of the fingers, and has a large base formed into an oblong cavity, whose greatest length is from one side to the other. Round it several tubercles may be remarked, for the insertion of ligaments. Its body is convex, or a half-round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous sheaths that are fixed on each side to the angle at the edge of this flat surface. The lower end of this second bone has two lateral round protuberances, and a middle cavity, whose greatest extent of smooth surface is forwards.

The articulation and motion of the upper end of this second bone is as singular as that of the former. For its cavity being joined to the round head of the first bone, it would seem at first view to move in all directions; yet, because of the strength of its lateral ligaments, oblong figure of the joint itself, and mobility of the first joint, this joint can be bended and extended only.

The bones of the fingers are arranged in three

bones, named *phalanges* *. All of them have half round convex surfaces, covered with an *aponeurosis*, formed by the tendons of the *extensors*, *lumbricales*, and *interossei*, and placed directly backwards, for their greater strength, and their flat concave part is forwards, for taking hold more surely, and for lodging the tendons of the flexor muscles. The ligaments for keeping down these tendons are fixed to the angles that are between the convex and concave sides.

The bones of the first phalanx of the fingers, answer to the description of the second bone of the thumb: only that the cavity in their base is not so oblong; nor is their motion on the metacarpal bones so much confined: for they can be moved laterally or circularly, but have no rotation or a very small degree of it round their axis.

Both the ends of this first phalanx are in a cartilaginous state at birth; and the upper one is afterwards affixed in form of an *epiphyse*.

The second bone of the fingers has its base formed into two lateral cavities, and a middle protuberance; while the lower end has two lateral protuberances and a middle cavity: therefore it is joined at both ends in the same manner, which none of the bones of the thumb are.

* Sejtalidæ, internodia, scuticula, agmina, acies, condyle. articuli.

This bone is in the same condition with the former in children.

The third bone differs nothing from the description of the second bone of the thumb, excepting in the general distinguishing marks; and therefore the second and third phalanx of the fingers enjoy only flexion and extension.

The upper end of this third phalanx, is a cartilage in a ripe child; and is only an epiphyse after, till the full growth of the body.

The phalanges of the several fingers differ only as to magnitude. The bones of the middle finger being the longest and largest, those of the forefinger come next to that in thickness, but not in length, for those of the ring-finger are a little longer. The little-finger has the smallest bones. Which disposition is the best contrivance for holding the largest bodies; because the longest fingers are applied to the middle largest periphery of such substances as are of a spherical figure *.

Lest I should seem to have forgot the small bones at the joints of the hand, I desire now to refer to the description of them, under the common title of *sesamoid bones*, which I have placed after the bones of the feet.

* Galen de usu part. lib. 1. cap. 24.

CHAPTER II.

OF THE APONEUROSIS, AND MUSCLES OF THE SUPERIOR EXTREMITIES.

THE muscles of the superior extremities may be arranged into the following classes, 1. Into the muscles of the shoulder; 2. Into the muscles of the arm; 3. Into the muscles of the fore-arm; 4. Into the muscles of the hand *.

* I have adopted the names of some of the muscles, which have been proposed by Professor DUMAS, of Montpellier; and to render these intelligible to my reader, have subjoined the following table, as he has also changed the names of the processes of the bones.

NEW TERMS OF DUMAS.	OLD NAMES.
SUS-ACROMION,	The edge of the Clavicle above the Acromion of the Scapula.
SOUS-ACROMION,	Edgo of the same bone beneath the same process.
TROCHITER,	Greater protuberance of the Os Humeri.
TROCHIN,	Lesser protuberance of the Os Humeri.
EPITROCHLEE,	The internal condyle of the Os Humeri.

Sect. I.

OF THE APONEUROSIS OF THE SUPERIOR EXTREMITY, AND MUSCLES PROPER TO IT.

The muscles of the superior extremity are covered and fixed down by a tendinous aponeurosis, which extends from the different processes of the bones, and is by some authors said to take its origin from these.

The tendinous aponeurosis is thicker on the outer than on the inner side of the arm, and it is thicker on the fore-arm than on the humerus, and at the wrist, the fibres of it are thicker, and are said to form the annular ligaments.

The superficial veins of the arm are disposed between the skin, and the tendinous aponeurosis, and also the branches of the superficial nerves, and many lymphatic vessels.

There is a strong fascia in the fore-arm, as in the leg.

The fascia is attached to the condyles of the humerus, and to the olecranon Ulnæ, and it is

Epicondyle,	The external condyle of the Os Humeri.
Phalange,	The 1st phalanx of the Fingers or Toes.
Phalangine,	The 2d phalanx.
Phalangette,	The 3d phalanx.

stronger on the back than on the fore-part of the arm, in consequence of the addition of tendinous fibres from the triceps extensor muscle: and the tendinous aponeurosis of the fore-part of the arm is rendered stronger by the addition of tendons from the scapulo-radialis muscle.

This fascia sends processes between the muscles of the fore-arm, which have been named by some authors *intermuscular ligaments*, from which many tendinous muscular fibres take their origin.

At the wrist there are two annular ligaments, the *ligamentum carpi annulare posterius*, under which the tendons of the extensor muscles pass, which extends transversly between the styloid process of the ulna, and os pisiforme, and is fixed to the styloid process of the ulna, and the *ligamentum carpi anterius*, which passes across the fore-part of the wrist, extends between the os pisiforme and os unciforme, and the os scaphoides, and under this, the tendons of the flexor muscles pass to the hand.

In the palm of the hand, there is a strong fascia, which is connected with the tendon of the palmaris longus, and which covers the greater share of the palm of the hand, and is fixed to the roots of the fingers by an equal number of double slips of tendon.

There are two muscles proper to the tendinous aponeurosis of the superior extremity, the Epitrochlo-Palmaris, or *Palmaris Longus*, and the Palmaro-Cutaneus, or *Palmaris Brevis*.

EPITROCHLO-PALMARIS, or *Palmaris Longus.*

This muscle, which takes its origin from the internal condyle of the os humeri, and is fixed into the ligamentum carpi annulare, by means of its tendon, stretches the tendinous aponeurosis, and assists in bending the hand.

PALMARO-CUTANEUS, or *Palmaris Brevis.*

This small muscle, which crosses the aponeurosis of the palm of the hand, and extends between the ligamentum carpi annulare anterius, and the aponeurosis palmaris, and is fixed into the skin which covers the abductor minimi digiti and os pisiforme; assists in contracting the palm of the hand.

SECT. II.

MUSCLES OF THE SHOULDER.

COSTO-SCAPULARIS, or *Serratus Anticus Major.*

This muscle is connected to the nine superior ribs, and is inserted into the whole length of the base of the scapula.

The under part of this muscle pulls the shoulder downwards and forwards, and the upper antagonize the under *.

* Vid. Plate xxii. letters EE.

TRACHELO-SCAPULARIS, or *Levator Scapulæ.*

This muscle takes its rise by fleshy slips from the transverse processes of the five superior cervical vertebræ, and is fixed into the superior angle of the scapula.

By this muscle the scapula is raised, and pulled forwards.

COSTO-CORACOIDEUS-SCAPULARIS, or *Pectoralis Minor.*

This muscle takes its origin from the 3d, 4th and 5th ribs, passes obliquely outwards, and is fixed into the coracoid process of the scapula; it pulls the scapula downwards, and also forwards; or it may raise the ribs during a laborious inspiration.

DORSO-SUB-ACROMIALIS, or *Trapezius.*

This muscle arises from the middle of the occipital arch, from the corresponding muscle, over the spinous processes of the cervical vertebræ, from the spinous processes of the two inferior cervical, and all the dorsal vertebræ; and is inserted into the whole of the spine of the scapula, the acromion scapulæ, and the scapulary part of the clavicle.

The different portions of this muscle are subservient to different purposes, the superior part raises the shoulder; the lower part pulls it down-

wards, and the middle portion draws the shoulders towards each other; and when the scapulæ are fixed, this muscle assists in moving the head backwards.

Dorso-Scapularis, or *Rhomboideus.*

This muscle, which arises from the spinous processes of the 5th 6th, and 7th cervical vertebræ, and the four uppermost dorsal vertebræ, is fixed into the whole length of the base of the scapula, and tends to draw the scapula backwards and upwards.

Costo-Clavius, or *Subclavius.*

This muscle fills up the space between the clavicle and first rib; it arises from the cartilage of the first rib, and is fixed into the under surface of the clavicle, as far as the coracoid process of the scapula.

It pulls the clavicle down.

Scapulo-Hyoideus, or *Omo-hyoideus.*

This muscle arises from the superior costa of the scapula, and passes obliquely upwards, and forwards under the sterno-mastoideus, under which it becomes tendinous, and is fixed into the base of the os hyoides, at the side of the sterno-hyoideus.

By this muscle the os hyoides is pulled down to one side, and when both muscles act, the os hyoides is drawn directly downwards.

Sect. III.

MUSCLES OF THE ARM.

The muscles of the arm arise from the trunk of the body, or from the processes of the scapula.

Sterno-Humeralis, or *Pectoralis Major.*

This muscle rises from the upper and middle bone of the sternum, sternal portion of the clavicle, and the cartilages of the 5th and 6th ribs, it covers the front of the breast, and is fixed by a flat twisted tendon, into the ridge which bounds the outer edge of the groove for the tendons of the long head of the scapulo-radialis muscle.

By this muscle, the humerus is brought forward, and the arm thrown across the breast *.

Lumbo-Humeralis, or *Latissimus Dorsi.*

This thin and broad muscle, which covers the greater share of the back-part of the trunk of the body, takes its rise from the os sacrum, crest of the os ilium, and spinous processes of the lumbar and seven inferior dorsal vertebræ, and from the extremities of the four lowest ribs. The fleshy fibres ascend obliquely, pass over the inferior angle of the scapula, are collected, twisted in the axilla, and then fixed into the inner edge of the groove which receives the long tendon of the scapulo-radialis †.

* Vid. Plate xxii. letters DDDD.

† Vid. Plate xxii. letter C.

This muscle pulls the humerus backwards and downwards, and also rolls it.

The following muscles arise from the scapula, the three first roll the os humeri outwards, and the other two antagonize these.

The two following muscles are covered by an aponeurosis extending between the costæ, and spine of the scapula.

SUPER-SCAPULO-TROCHITEREUS PARVUS, or *Supra-Spinatus.*

This muscle arises from that part of the scapula which is above the spine of the scapula, and from the spine and superior costa of the scapula, and its tendons pass under the acromion above the articulation, and are fixed into the anterior part of the great tuberosity of the humerus.

This muscle also assists in raising the arm.

SUPER-SCAPULO-TROCHITEREUS MAGNUS, or *Infra-Spinatus.*

This muscle fills up the greater part of the scapula, which is below the spine of that bone, the fibres of it are oblique in respect to its tendon, which is fixed into the middle part of the greater tuberosity of the os humeri.

This muscle assists in raising the arm, and rolls it outwards when raised.

SUPER-SCAPULO-TROCHITEREUS MINIMUS, or *Teres Minor.*

This muscle arises from the inferior edge of the scapula, between the infra-spinatus and teres major; it ascends along the under edge of the infra-spinatus, and is fixed into the back-part of the larger tuberosity of the os humeri.

SCAPULO-HUMERALIS, or *Teres Major.*

This muscle arises from the dorsal side of the inferior angle of the scapula, and is fixed into the ridge, at the inner side of the groove for lodging the long head of the scapulo-radialis, along with the tendon of the latissimus dorsi.

The use of this muscle is to roll the os humeri inwards.

SUB-SCAPULO-TROCHINEUS, or *Sub-Scapularis.*

This muscle is concealed by the scapula, fills up the space under it, from the three costæ of which it takes its origin.

The radiated fibres of this muscle make prints upon the bone.

It is fixed into the smaller tuberosity of the os humeri, which it rolls inwards.

SUB-ACROMIO-HUMERALIS, or *Deltoides.*

This thick and strong mass of flesh arises from the sternal half of the clavicle, from the acromion,

and part of the spine of the scapula: the fasciculi of this muscle are very large and distinct; and it has by some authors been divided into three distinct, and has been represented as three different muscles by LIONARDO DA VINCI in his anatomical drawings *.

It is inserted by a strong tendon, into a rough surface on the outer side of the os humeri, near to its middle.

The different portions of this muscle are subservient to different purposes. If the middle portion only be thrown into action, the arm is raised; if the anterior part acts, the arm is thrown forwards; and if the posterior portion be thrown into action, the arm is drawn downwards and backwards.

CORACO-HUMERALIS, or *Coraco Brachialis.*

This muscle arises, in common with the biceps muscle, from the fore-part of the coracoid process of the scapula, and is fixed into the middle of the humerus, which it raises towards the shoulder obliquely.

SECT. IV.

MUSCLES OF THE FORE-ARM.

There are two Flexors, and only one Extensor of the fore-arm.

* These drawings are in his Majesty's collection, and engravings from them have been published by Mr CHAMBERLAINE.

Of the Flexor Muscles.

Scapulo-Radialis, or *Biceps Flexor Cubiti.*

This muscle has two origins, one in common with the coraco-brachialis, from the coracoid process of the scapula, and the other, the longer, from the upper-part of the glenoid cavity: the longer head passes over the ball of the os humeri within the joint, and it is retained by a ligament within a groove in the upper-part of the os humeri; and is fixed into a small tubercle on the upper and inner side of the radius, and into the aponeurosis of the fore-arm.

By this muscle the fore-arm is bent, the hand is turned supine, and the fascia is tightened *.

Humero-Ulnaris, or *Brachialis Internus.*

This muscle takes its rise from the lower third of the anterior part of the os humeri; and it passes over the joint adhering to the capsular ligament, and is fixed into the coronoid process of the ulna.

Of the Extensor Muscles.

Olecrano-Scapularis, or *Triceps Extensor Cubiti.*

This muscle arises by three heads.

The first or longest share of this muscle arises from the edge of the scapula near its neck; the

* Vid. Plate xxii. A. left arm.

second from the posterior surface of the os humeri; and the third or shortest from that part of the posterior part of the os humeri, which is below the glenoid cavity.

The three heads are united by a broad tendon, which covers the posterior part of the humerus, and is fixed into the upper and outer part of the olecranon ulnæ, and into the condyles of the os humeri. This muscle is seen in action in the right arm in Plate xxii. letter B.

Epicondylo-Cubitalis, or *Anconeus.*

This muscle, which arises from the posterior part of the external condyle of the os humeri, and is inserted into a ridge on the outer and back-part of the ulna, assists the triceps in extending the fore-arm.

Sect. V.

Of the Supinator and Pronator Muscles.

There are two bones in the fore-arm, the Ulna and Radius. The former is moved in the flexion and extension of the fore-arm; the latter in the supination and pronation, or in those actions, in which the palm of the hand is turned upwards and downwards.

There are two muscles by which *supination* is performed.

Supinator Muscles.

HUMERO-SUPER-RADIALIS, or *Supinator Radii Longus.*

This muscle arises from a ridge of the os humeri above the external condyle of the os humeri, and is inserted by means of a long tendon into the lower head of the radius, which it moves from within outwards upon the ulna.

EPICONDYLO-RADIALIS, or *Supinator Radii Brevis.*

This muscle takes its origin from the external condyle of the os humeri, and from the outer and upper part of the ulna, and from the interosseous ligament: it is wrapt around the upper and forepart of the radius, which it turns upon its axis.

The supinator muscles are counteracted by two pronator muscles.

Pronator Muscles.

EPITOCHLO-RADIALIS, or *Pronator Radii Teres.*

This muscle takes its origin from the internal condyle of the os humeri, and from the coronoid process of the ulna, and, becoming gradually smaller, it extends across the upper end of the flexor muscles of the wrist, and is fixed into the interior and upper part of the radius.

CUBITO-RADIALIS, or *Pronator Radii Quadratus.*

This muscle extends between the carpal extremities of the ulna and radius.

SECT. VI.

MUSCLES OF THE HAND.

Muscles of the Carpus and Metacarpus.

The muscles of the carpus have been named *radial* or *ulnar*, according to the side of the fore-arm along which they pass, and *internal* or *external*, according to the condyle of the humerus, from which they take their origin.

Two of the muscles of the carpus are *flexors*, and three *extensors* of the hand.

EPITROCHLO-METACARPEUS or *Flexor Carpi Radialis.*

This muscle proceeds from the internal condyle of the os humeri, and from the fore and upper part of the ulna : its tendon is long, and passes through the fossa of the os trapezium, and is inserted into the fore and upper part of the metacarpal bone of the fore-finger.

By this muscle the wrist is not only bent, but the hand is thrown into a state of pronation.

Epitrochlo-Carpalis, or *Flexor Carpi Ulnaris.*

This muscle takes its origin from the internal condyle of the os humeri, and from the olecranon ulnæ; it passes along the inner side of the ulna, and is inserted into the os pisiforme.

This muscle assists the former.

Humero-Super-Carpeus, or *Extensor Carpi Longior.*

This muscle arises immediately below the supinator radii longus, from the ridge above the external condyle of the os humeri, it passes along the radius, and its tendon is fixed down by the ligamentum carpi annulare, and is fixed into the upper and back part of the metacarpal bone of the fore-finger.

Epicondylo-Super-Metacarpeus, or *Extensor Carpi Brevior.*

The origin of this muscle is similar to that of the former, excepting that a few of its fibres are also connected with the capsular ligament of the joint; its tendon also passes under the annular ligament in the same groove with that of the former muscle; and is inserted into the upper and back part of the metacarpal bone of the middle finger.

The two last named muscles extend the wrist.

CUBITO-SUPER-METACARPEUS, or *Extensor Carpi Ulnaris.*

This muscle arises from the external condyle of the os humeri, and from the middle of the ulna, and its round tendon is inclosed in a sheath in a groove at the back-part of the carpal extremity of the ulna, and is at length fixed into the upper part of the metacarpal bone of the little finger.

This muscle extends the wrist, and draws the hand towards the little finger.

SECT. VII.

MUSCLES OF THE FINGERS AND THUMB.

There are two flexor muscles common to the fingers, and only one extensor. There are two flexors, three extensors, an abductor, an adductor, and an opponens proper to the thumb.

There is an extensor, a flexor, and an adductor of the fore-finger, and a flexor, an abductor, and an adductor proper to the little finger. Besides these muscles, there are muscles between the bones of the fingers, called from their situation *interossei*, which move the fingers laterally.

EPICONDYLO-SUPER-UNGUIALIS, or *Extensor Communis Digitorum.*

This muscle arises from the external condyle of the humerus, and divides upon the back of the

fore-arm into four tendons, which are fixed into the posterior part of all the bones of the fingers.

By this muscle the fingers are extended.

EPITROCHLO-PHALANGEUS, or *Flexor Digitorum Sublimis Perforatus.*

This muscle takes its origin from the internal condyle of the os humeri, and from the coronoid process of the ulna, and also from the fore-part of the radius. The muscle divides into four tendons, which pass under the anterior annular ligament, and are inserted into the second phalanx of the fingers; and at the first phalanx, the tendons are perforated by those of the flexor digitorum profundus.

PALMO-PHALANGEUS, or *Lumbricalis.*

These four muscular slips are connected to the tendons of the last-named muscle; and at the under ends of the metacarpal bones, they send off small tendons, which are fixed into the tendons of the interossei muscles, about the middle of the first phalanx.

These muscles have but little effect; they increase the power of the flexors of the fingers.

CUBITO-SUB-UNGUIALIS, or *Flexor Digitorum Profundus.*

This muscle arises from the upper part of the ulna, and from the interosseous ligaments; it is placed behind the flexor sublimis, and divides into

four tendons, which are fixed into the upper part of the third phalanx of the fingers.

By the flexor sublimis, the second and first phalanges of the fingers are bent; and by the latter, the third phalanx.

Muscles of the Thumb.

RADIO-SUB-UNGUIALIS, or *Flexor Longus Pollicis Manus.*

This muscle, which arises from the fore-part of the radius, and from the interosseous ligament, passes under the annular ligament, and is fixed into the last joint of the thumb; which is bent by it.

CARPO-PHALANGEUS, or *Flexor Brevis Pollicis.*

This muscle arises from the os trapezoides, os magnum, and os unciforme; it is divided into two portions by the flexor longus, and is fixed into the base of the first bone of the thumb, and ossa sesamoidea: by this muscle the first joint of the thumb is bent.

CARPO-METACARPALIS, or *Opponens Pollicis.*

This muscle, which lies under the abductor pollicis, takes its origin from the os trapezium, and ligamentum carpi annulare, and is inserted into the under and fore-part of the metacarpal bone of the thumb.

This muscle brings the thumb inwards, and makes it oppose the fingers.

CARPO-SUPER-PHALANGEUS, or *Abductor Pollicis.*

This muscle is placed under the skin, and arises from the os trapezium and ligamentum carpi annulare, and is fixed into the outer side of the root of the first bone of the thumb. The use of the muscle is to draw the thumb from the fingers.

METACARPO-PHALANGEUS-POLLICIS, or *Adductor Pollicis.*

This muscle takes its origin from the metacarpal bone of the middle finger, crosses the metacarpal bone of the fore-finger, and it is fixed into the root of the first bone of the thumb, on its inner side.

By this muscle, the thumb is drawn towards the fingers.

CUBITO-SUPER-METACARPEUS POLLICIS, or *Extensor Ossis Metacarpi Pollicis.*

This muscle takes its rise from the middle of the posterior part of the ulna, radius, and interosseous ligament; it passes obliquely over the radius, aad is fixed into the os trapezium, and upper and back part of the metacarpal bone of the thumb, which it extends.

CUBITO-SUPER-PHALANGEUS PRIMUS POLLICIS, or *Extensor Primi Internodii Pollicis.*

This muscle, which arises from the back-part of the ulna, and from the interosseous ligament, and is fixed into the posterior part of the first bone of the thumb; tends to extend the first joint of the thumb.

CUBITO-SUPER-PHALANGEUS SECUNDUS POLLICIS or *Extensor Secundi Internodii Pollicis.*

This muscle takes its origin from the middle and back-part of the ulna, and from the interosseous ligament, and is inserted into the last joint of the thumb, which it extends.

CUBITO-SUPER-PHALANGEUS PRIMUS INDICIS, or *Indicator.*

This muscle, which arises from the middle and posterior part of the ulna, the tendon of which is contained in the same sheath as the extensor digitorum communis; is fixed into the posterior part of the fore-finger, which it extends, as in pointing.

Muscles of the Little Finger.

CARPO-PHALANGEUS SECUNDUS, or *Flexor Parvus Minimi Digiti.*

This muscle, which lies on the inner side of the abductor minimi digiti, takes its origin from the

outer side of the os unciforme, and from the annular ligament of the wrist, and it is inserted by a round tendon into the base of the first phalanx of the little finger.

By this muscle the little finger is bent.

CARPO-PHALANGEUS MINIMI DIGITI, or *Abductor Minimi Digiti Manus.*

This muscle arises from the os pisiforme, and annular ligament of the wrist, and its fibres extend along the metacarpal bone of the little finger, and are inserted into the inner side of the first phalanx.

By this muscle the little finger is drawn from the other fingers.

CARPO-METACARPEUS MINIMI DIGITI, or *Adductor Minimi Digiti.*

This muscle arises from the os unciforme, and is inserted by a tendon into the root of the first phalanx of the fore-finger.

In the palm of the hand, this muscle is covered by the muscles of the thumb.

By this muscle, the fore-finger is drawn towards the thumb, or the thumb is drawn towards the fore-finger.

Of the Muscles between the Fingers, called METACARPO-PHALANGEI LATERALES, *or Interossei.*

There are two strata of interossei muscles, an external and internal.

These muscles take their origin from the sides of the metacarpal bones, and are fixed by slender tendons, into the tendinous expansions of the extensor digitorum communis.

By these muscles, the fingers are moved laterally, and they also assist in bending or extending the phalanges of the fingers.

There are four *interossei interni* in the palm of the hand.

The 1st, called *prior indicis*, takes its origin from the outer part of the metacarpal bone of the fore-fingers, and is inserted into the outer side of the first phalanx of that finger.

By this muscle, the fore-finger is drawn towards the thumb.

The 2d, named *posterior indicis*, arises from the root and inner side of the metacarpal bone of the fore-finger, and is inserted into the inner side of the first phalanx of the fore-finger.

By this muscle, that finger is drawn outwards.

The 3d, named *prior annularis*, arises from the root and outer side of the metacarpal bone of the ring-finger, and is inserted into the outer side of the first phalanx of the same finger.

By this muscle, the ring-finger is drawn towards the thumb.

The 4th, named *interosseus auricularis*, takes its rise from the root and outer side of the metacarpal bone of the little finger, and is inserted into the outer side of the first phalanx of the little finger.

By this muscle, the little finger is drawn outwards.

There are only three *interossei externi*, called *bicipites*, these are larger than the internal, and are situated between the metacarpal bones on the back of the hand.

Prior medü digiti, arises from the corresponding sides of the metacarpal bones of the fore and middle fingers, and is fixed into the inner side of the tendon on the back of the middle finger.

CHAPTER III.

BURSÆ MUCOSÆ OF THE SUPERIOR EXTREMITIES.

SECT. I.

BURSÆ IN THE VICINITY OF THE SHOULDER-JOINT.

THERE are several bursæ around this joint.

There is a *bursa* which may be named *coracobrachialis*, as it is situated between the origin of

the coraco-brachialis muscle, the scapulo-radialis muscle, and the capsular ligament of the joint.

There is a *bursa*, under the head of the os humeri, between it and the tendon of the teres major muscle and that bone.

There is a *bursa* between the tendon of the latissimus dorsi and the os humeri.

There is a *large bursa* between the acromion scapulæ, the coracoid process, and capsular ligament of the shoulder-joint, and also a small bursa between the coracoid process and capsular ligament of the humerus; this, however, is sometimes wanting.

There is a *bursa* above the tendon of the infraspinatus, and teres major muscle.

There is a *bursa* between the clavicle and coracoid process of the scapula.

There is a *bursa* between the subclavian muscle and first rib.

There is a *bursa* between the clavicle and coracoid process, where the former bone works on the coracoid process.

There is a *vaginal shaped bursa*, which incloses the tendon of the long head of the scapulo-radialis muscle: and there is a *very small bursa* placed under that part of the muscle which passes over the head of the os humeri: and a *bursa* is also placed under the tendon of the subscapularis muscle, which communicates with the cavity of the joint.

Sect. II.

BURSÆ MUCOSÆ SITUATED NEAR THE ELBOW-JOINT.

There is a *bursa* between the tendons of the biceps bracheus internus, and anterior tubercle of the radius. The tubercle of the radius is incrusted with cartilage, lined with the membrane of the bursa, and within the bursa there is a peloton of fat.

There is a *bursa* between the tendon of the biceps and the ligament, which is common to the radius and ulna.

There is a *bursa* between the olecranon ulnæ and tendon of the triceps extensor cubiti.

Sect. III.

BURSÆ OF THE INFERIOR PART OF THE FORE-ARM AND HAND.

There is a *large bursa* behind the flexor longus pollicis manus, between it and the fore-part of the radius, and capsular ligament of the wrist.

A *bursa* is placed behind the tendons of the flexor digitorum profundus on the fore-part of the capsular ligament of the wrist; and in some subjects, this communicates with the following *very*

large bursa, for the tendon of the flexor pollicis longus.

A *bursa* is placed between the tendon of the flexor carpi radialis and os trapezium.

There is a *bursa* between a tendon common to the extensor carpi radialis brevis, and extensor digitorum communis.

There is a *very small bursa* between the tendon of the flexor carpi ulnaris and os pisiforme.

CHAPTER IV.

LIGAMENTS OF THE SUPERIOR EXTREMITY.

SECT. I.

LIGAMENTS OF THE CLAVICLE AND SCAPULA.

Front View.

THERE are a number of ligamentous fibres which inclose the capsular ligament, which connects the clavicle to the breast-bone, and within that joint, there is an *inter-articular cartilage.*

There is a ligament which passes across the sternum, from one clavicle to the other.

There is a ligament, *of a rhomboidal figure*, which extends between the under surface of the clavicle, at no great distance from its neck, to the cartilage of the first rib.

There is a ligament, called by CALDANI *bicorne*, which arises from the coracoid process of the scapula, and ascends obliquely, and divides into two parts; the one of which is fixed into the inferior part of the clavicle near to the rhomboidal ligament; the other part of it is fixed into the first rib, under the tendon of the subclavian muscle.

There are two thin ligaments (between which there is a bursa mucosa,) which are stretched between the coracoid process of the scapula, and the middle and under part of the clavicle, and between these ligaments and the ligamentum bicorne, the subclavian muscle is placed.

In this front view, the anterior proper ligament of the scapula is seen, passing between the coracoid process of the scapula and the acromion scapulæ.

On the upper and fore part of the capsular ligament of the shoulder-joint, the ligamentous membrane, which WEITBRECHT has named *adscititia*, is seen; and beneath it, the whole extent of the capsular ligament, covered and strengthened by the tendons of the adjacent muscles, and which is connected with the neck of the scapula, and is fixed into the neck of the os humeri.

The long head of the biceps passes through the joint of the os humeri, and is confined within the

groove in the os humeri situated between its tubercles, by a ligamentous sheath.

Back View.

The proper posterior ligament is stretched across the semilunar notch of the scapula, and forms that notch into an aperture for the superior and posterior bloodvessels and nerves of the scapula.

Sometimes this ligament is double.

Anatomists have supposed that this hole is covered by ligament, in order to prevent the vessels which pass through it, being injured by friction during the movements of the scapula.

There is a ligament, somewhat *of a conical figure*, and hence called *conoid*, which is in part connected with the last-named ligament, and with the coracoid process of the scapula, and which is fixed near to the junction of the clavicle with the scapula.

Upon cutting into the capsular ligament of the shoulder-joint, it is found to be of unequal thickness; and at the upper and outer side of the neck of the os humeri, the synovial apparatus may be seen.

Sect. II.

LIGAMENTS OF THE ELBOW-JOINT.

The capsular ligament at the *elbow-joint* is much less extensive, than that at the shoulder-

joint; it is connected with the lower end of the os humeri, and fixed around the edge of the articular surface of the ulna, and also to the coronary ligament of the radius.

On each side of the capsular ligaments, there are *lateral ligaments*, the internal, or *humero-ulnar*, passing between the internal condyle of the os humeri, and the coronoid process of the ulna, and the external, or *humero-radial*, which is larger than the other, extending between the external condyle of the os humeri, and the accessory ligament.

There is an *annular ligament*, which encircles the neck of the radius, and is fixed to the opposite sides of the semilunar cavity of the ulna. By this ligament, the radius is fixed down, during the pronation and supination of the hand.

There are a number of *additional ligamentous fibres* which pass over the capsular ligament in different directions, and have been named *accessory ligaments*.

Sect. III.

LIGAMENTS BETWEEN THE RADIUS AND ULNA.

There is a strong *ligamentous membrane*, extending between the sharp ridges of the radius and ulna, the fibres of which extend obliquely downwards and inwards.

This ligament is perforated in several places by bloodvessels, and there is a large opening at the upper part of it, which is filled by muscles.

This ligament not only binds together the radius and ulna, and limits the rotation of the radius, but also gives origin to many muscular fibres.

There is a capsular ligament which incloses the carpal end of the ulna, which arises from the edges of the semilunar cavity at the carpal end of the ulna.

Sect. IV.

LIGAMENTS BETWEEN THE FORE-ARM AND WRIST.

There is a capsular ligament extending between the margin of the glenoid cavity of the radius, and the cartilaginous edges of the os scaphoides, lunare, and cuneiforme.

There are two lateral ligaments, one placed between the styloid process of the radius, and the os naviculare, and the other, between the styloid process of the ulna, and the cuneiform and pisiform bones.

There is also an *internal mucous ligament* within the joint, which extends between the two first bones of the carpus, and the radius.

Sect. V.

LIGAMENTS OF THE CARPUS.

The ligaments called *annular*, formed by the aponeurosis of the muscles, have been already described.

There is a capsular ligament between the upper and under rows of bones which compose the carpus, which is strengthened by a great number of short ligamentous fibres, which cross the capsular ligament in different directions, and have been called *oblique*, *transverse*, and *perpendicular ligaments*.

Sect. VI.

LIGAMENTS BETWEEN THE CARPAL AND METACARPAL BONES.

The second row of the carpal bones is united to the neighbouring bones by capsular ligaments; and there are various additional ligamentous fibres, which have been named *oblique*, or *straight* ligaments, from the direction of their fibres.

Sect. VII.

ARTICULAR LIGAMENTS OF THE METACARPAL BONES.

There are capsular or articular and also *lateral ligaments* placed at the sides of these joints, for the sake of additional security.

There are also ligaments extending between the bases of the metacarpal bones, which are placed transversely, and fix these bones firmly to each other; and which have been named *palmar* and *dorsal ligaments*.

There are also interosseous ligaments at the heads of the metacarpal bones, which in the palm of the hand are transverse, and fix the heads of these bones to each other.

Sect. VIII.

LIGAMENTS FOR RETAINING THE TENDONS OF THE MUSCLES OF THE HAND, FINGERS, AND THUMB.

There are vaginal ligaments, lined with bursæ mucosæ, which inclose the tendons of the flexor digitorum sublimis, and also those of the flexor digitorum profundus.

There are crucial ligaments, which bind down the tendons of the flexor muscles.

There are also accessory ligaments of the flexor tendons, which arise from the first and second phalanges of the fingers; and are lodged within the vaginal ligaments, which terminate in the tendons of the flexor muscles, and assist in retaining the tendon of the flexor muscles in their places.

The tendons of the extensor muscles are united by transverse ligaments, near to the heads of the metacarpal bones, and are thus retained in their places.

INFERIOR EXTREMITIES.

CHAPTER I.

BONES OF THE INFERIOR EXTREMITIES.

THE *inferior extremities* have commonly been divided into three parts, viz. the *thigh*, *leg*, and *foot*.

Of the Thigh.

The THIGH-BONE*, the longest, the largest and strongest of the cylindrical bones; is not placed perpendicularly: The lower end is inclined considerably inwards; so that the knees are almost contiguous, while there is a considerable distance between the thigh-bones above: thus sufficient space is left for the external parts of the organs of generation, and for the two great cloacæ of urine and fæces, and for the large thick muscles that move the thighs inwards: And, at the same time, this situation of the thigh-bones renders our progression quicker, surer, straighter, and in less

* Μηρὸν, Femen, coxa, agis, anchæ os, crus, femur.

room; for had the knees been at a greater distance from each other, we must have been obliged to describe some part of a circle with the trunk of our body in making a long step, and, when one leg was raised from the ground, our centre of gravity would have been too far from the base of the other, and we should consequently have been in hazard of falling; so that our steps would neither have been straight nor firm; nor would it have been possible to walk in a narrow path, had our thigh-bones been otherwise placed *.

This end is formed into a large smooth round head †, which is the greater portion of a sphere unequally divided.

Towards its lower internal part, a round rough spongy pit is observable, where the strong ligament, commonly, but unjustly, called the *round* one, is fixed, to be extended from thence to the lower internal part of the receiving cavity, where it is considerably broader than near to the head of the thigh-bone.

The small part below the head, called the *cervix*, of the os femoris, has a great many large holes, into which the fibres of the strong ligament,

* The form of the thigh-bone, and also the angle which the body of that bone makes with its head, are materially different in the ricketty and healthy child. In the former, the head and neck of the bone form with its body a right angle, having yielded to the weight of the body. Hence, a ricketty child straddles in an unnatural manner in walking or running.

† Vertebrum.

continued from the capsular, enter, and are thereby securely fixed to it; and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.

Below the back-part of this root, the large unequal protuberance, called *trochanter major*, stands out; the external convex part of which, is divided into three different surfaces; that on the fore-part is scabrous and rough, for the insertion of the glutæus minimus; but the superior one into which the glutæus medius is inserted, is smooth; and that behind is made flat and smooth by the tendon of the glutæus maximus passing over it.

The upper edge of this process is sharp and pointed at its back-part, where the glutæus medius is fixed; but forwards it is more obtuse, and has two superficial pits formed in it: Into the superior of these, the piriformis is implanted; and the obturator internus and gemini are fixed into the lower one.

From the posterior prominent part of this great trochanter, a rough ridge runs backwards and downwards, into which the quadratus is inserted.

In the deep hollow, at the internal upper side of this ridge, the obturator externus is implanted. More internally, a conoid process, called *trochanter minor*, rises for the insertion of the musculus psoas, and iliacus internus, and the pectineus, is

implanted into a rough hollow below its internal root.

The muscles inserted into these two processes are the principal instruments of the rotatory motion of the thigh.

Bruises by falls on this part, are, on account of the tendons which are fixed into, or pass over the great trochanter, attended with great pain and weakness of the limb of long duration.

The body of the os femoris is convex on the fore-part, and concave behind. The fore-part of the thigh-bone is a little flatted above by the beginning of the cruræus muscle, as it is also below by the same muscle and the rectus. Its external surface is likewise flat below. The posterior concave surface has a ridge rising in its middle, commonly called *linea aspera*, into which the triceps is inserted, and the short head of the biceps flexor tibiæ rises from it.

At the upper part of it the medullary vessels enter by a small hole that runs obliquely upwards.

A little above which, there is a rough fossa or two, where the tendon of the glutæus maximus is fixed. The lower end of the linea aspera divides into two, which descend toward each side. The two vasti muscles in part arise from these ridges; and the long tendon of the triceps is fixed to the internal, by means of part of the fascia aponeurotica of the thigh. Near the beginning

of the internal ridge, there is a discontinuation of the ridge, where the crural artery passes through the aponeurosis.

Between these two rough lines, the bone is made flat by the large bloodvessels and nerves which pass upon it; and near the end of each of these ridges, a small smooth protuberance may often be remarked, where the two heads of the external gastrocnemius muscle take their rise, and where sesamoid bones are sometimes found *; and from the fore-part of the internal tubercle, a strong ligament is extended to the inside of the tibia.

The lower end of the os femoris is extended into a great protuberance on each side, called its *condyles*; between which, a considerable cavity is found, especially at the back-part, in which the crural vessels and nerves lie immersed in fat. The internal condyle is longer than the external, which must happen from the oblique position of this bone, to give less obliquity to the leg.

Each of these processes seems to be divided in its plain smooth surface. The mark of division on the external is a notch, and on the internal, a small protuberance. The fore-part of this division, on which the rotula moves, is formed like a pulley, the external side of which is highest. Be-

* Vesal. lib. 1. cap. 28. & 30.

hind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the tibia; and from the rough cavity between them, but near to the base of the internal condyle, the strong ligament, commonly called the *cross* one, has its rise. A little above, which a rough protuberance gives insertion to the tendon of the triceps. On the back-part of the internal, a slight depression is made by the tendons of the gracilis and sartorius; and on the external, such another is formed by the biceps flexor cruris; behind which, a deep fossa is to be observed, where the poplitæus muscle has its origin.

From a tubercle immediately before this cavity, a strong round ligament goes out to the upper part of the fibula. Round this lower end of the thigh-bone, large holes are found, into which the ligaments for the security of the joint are fixed, and bloodvessels pass to the internal substance of the bone.

All the processes of the femur are cartilaginous in new-born children, and afterwards become small apophyses, with large epiphyses.

The thigh-bone is articulated above with the acetabulum of the ossa innominata, which affords its round head a secure and extensive play, and therefore can be moved to every side; but is restrained in its motion outwards, by the high brims of the cavity, and by the round ligament; for otherwise the head of the bone would have been

frequently thrust out at the breach of the brims on the inside, which allows the thigh to move considerably inwards.

The body of this bone has little or no rotatory motion, though the head most commonly moves round its own axis; because the oblique progress of the neck and head from the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this head, as in the arm, ever capable of being brought to a straight direction with its body; so far, however, as the head can move within the cavity backwards and forwards, the rest of the bone may have a partial rotation.

The os femoris is articulated below to the tibia and rotula.

The nearness of the small neck to the round head of the thigh-bone, and its upper end being covered with very thick muscles, make greater difficulty in distinguishing between a luxation and fracture here, than in any other part of the body.

Of the Leg.

The Leg * is composed, according to the common account, of two bones, *tibia* and *fibula*: a third, the *rotula*, may be added, from the strong

* Κνήμη, Crus, tibia.

analogy it bears to the olecranon of the ulna, and as it moves always with the other two.

Of the Tibia.

The TIBIA *, so called from its resemblance to an old musical pipe or flute, is a long thick triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The upper end of the tibia is large, bulbous, and spongy, and is divided into two cavities, by a rough irregular protuberance †, which is hollow at its most prominent part, as well as before and behind. The anterior of the crucial ligaments is inserted into the middle cavity, and the depression behind receives the posterior ligament.

The two broad cavities at the sides of this protuberance are not equal; for the internal is oblong and deep, to receive the internal condyle of the thigh-bone; while the external is more superficial and rounder, for the external condyle. In each of those two cavities of a recent subject, *a semilunar cartilage is placed*, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.

* Πρόκνημιον, ὀπίσκνημιον, focile majus, arundo major, canna major, canna domestica cruris.

† Διάφυσις, ἔξοχὴ νευροχονδρώδης, tuber, tuberculum.

The middle of each of these cartilages is broad, and the ends of them turn narrower and thinner, as they approach the middle protuberance of the tibia. The thick convex edge of each cartilage is connected to the capsular and other ligaments of the articulation, but so near to their rise from the tibia, that the cartilages scarcely change their place; while the narrow ends of the cartilages becoming almost ligaments, are fixed at the insertion of the strong cross ligament into the tibia, and seem to be united with it; therefore *a circular hole is left between each cartilage and the ligament*, in which the most prominent convex part of each condyle of the thigh-bone moves.

The circumference of these cavities is rough and unequal, for the firm connexion of the ligaments of the joint. Immediately below the edge at its back-part, there are two rough flatted protuberances: Into the internal, the tendon of the semimembranosus muscle is inserted; and a part of the cross ligament is fixed to the external. On the outside of this last tubercle, a smooth slightly-hollowed surface is formed by the action of the poplitæus muscle.

Below the fore-part of the upper end of the tibia, there is a considerable rough protuberance *, to which the strong tendinous ligament of the rotula is fixed.

* Ἀντίκνημιον, anterior tuber.

On the internal side of this, there is a broad scabrous slightly-hollowed surface, to which the internal long ligament of the joint, the aponeurosis of the vastus internus, and the tendons of the semitendinosus, gracilis and sartorius, are fixed.

The lowest part of this surface is therefore the place where the tibia ought to be sawed through in an amputation, to preserve its motions, by saving the proper muscles. Below the external edge of the upper end of the tibia, there is a circular flat surface covered in a recent subject with cartilage, for the articulation of the fibula;—between which, and the anterior knob, there is a rough hollow, from which the tibialis anticus, and extensor digitorum longus, take their origin.

From the smooth flat surface, a ridge runs obliquely downwards and inwards, to give rise to part of the solæus, tibialis posticus, and flexor digitorum longus, and insertion to the aponeurosis of the semimembranosus which covers the popliteus, and to some of the external fibres of this last named muscle. At the inside of this ridge, an oblique plain surface is left, where the greatest part of the musculus poplitæus is inserted. The remaining body of the tibia is triangular. The anterior angle is very sharp, and is commonly called the *spine* or *skin* *. This ridge is not

* Ακανθα, Spina, crea, linea prima tibiæ, angulus acutus.

straight; but turns first inwards, then outwards, and lastly inwards again.

The plain internal side is smooth and equal, being little subjected to the actions of muscles; but the external side is hollowed above by the tibialis anticus, and below by the extensor digitorum longus and extensor pollicis longus. The two angles behind these sides are rounded by the action of the muscles; the posterior side comprehended between them, is not so broad as those already mentioned, but is more oblique and flatted by the action of the tibialis posticus and flexor digitorum longus. Some way above the middle of the bone, the internal angle terminates. Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the tibia is made hollow, and a small protuberance rises from its middle. The internal side of this cavity, which is smooth, and, in a recent subject, is covered with cartilage, is prolonged into a considerable process, commonly named *malleolus internus* *; the point of which is divided by a notch, and from it ligaments are sent out to the foot. The internal malleolus is situated more forwards than the internal condyle of the upper end of this bone; which is necessary to be remembered in reducing a fracture of the leg †.

* Σφυρόν, πῆχυς, Talus, clavicula, clavilla interior, clavilla domestica.

† Winslow, Exposition Anatomique des Os secs. Sect. 265.

The external side of this end of the tibia* has a rough irregular semilunar cavity formed in it, for receiving the lower end of the fibula.

The posterior side has two lateral grooves, and a small middle protuberance. In the internal depression, the tendons of the musculus tibialis posticus and flexor digitorum longus are lodged; and in the external, the tendon of the flexor longus pollicis plays. From the middle protuberance, ligamentous sheaths go out, for tying down these tendons.

The articulations and motions of the tibia shall be explained, after all the three bones of the leg are described.

Both the ends of the tibia are cartilages at the birth, and become afterwards epiphyses.

Of the Fibula.

The FIBULA† is the small long bone, placed on the outside of the leg, opposite to the external angle of the tibia; the shape of it is irregularly triangular.

The head of the fibula has a superficial circular cavity formed on its inside, which, in a recent sub-

* The tibia is most frequently fractured at its lowest and smallest part.

† Παξαχνήμιον, Perone, Focile minus, arundo minor, canna minor cruris, sura, radius.

ject, is covered with a cartilage, but so closely connected to the tibia by ligaments, as to allow only a small motion backwards and forwards. This head is protuberant and rough on its outside, where a strong round ligament and the musculus biceps are inserted; and, below the back-part of its internal side, a tubercle may be remarked, that gives rise to the strong tendinous part of the solæus muscle.

The body of this bone is a little crooked inwards and backwards.

The sharpest angle of the fibula is forwards; on each side of which, the bone is considerably, but unequally depressed by the bellies of the several muscles that rise from, or act upon it; and, in old people, these muscles make distinct sinuosities for themselves.

The external surface of the fibula is depressed obliquely from above downwards and backwards, by the two peronæi.

Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected.

The anterior of the two planes is very narrow above, where the extensor longus digitorum and extensor longus pollicis arise from it; but is broader below, where it has the print of the nonus Ve-

salii. The posterior plane is broad and hollow, giving origin to the larger share of the tibialis posticus. The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the flexor digitorum longus take their rise. The posterior surface of the fibula is the plainest and smoothest, but is made flat above by the solæus, and is hollowed below by the flexor pollicis longus. In the middle of this surface the canal for the medullary vessels may be seen slanting downwards.

I have made particular mention of the course of the medullary vessels of the larger bones of the extremities*; because, in several chirurgical cases, a surgeon, who is ignorant of this, may do mischief to his patient. Thus, for example, if these vessels are opened very near to their entry into the bone, or while they are in the oblique passage through it, an obstinate hæmorrhagy may ensue: For the arteries being connected to the bony passage, styptics, are vainly applied; compressing instruments can do no service, and ligatures cannot be employed. *There seems to be a particular design in the contrivance of these canals;* those in the os humeri, tibia, and fibula, running obliquely downwards from their external entry; whereas in the radius, ulna, and os femoris, they slant upwards, whereby the arteries and nerves which

* Havers, Osteolog. nov. disc. 1. p. 59.

are sent into these three last bones, must suffer a considerable reflection before they come at the cancelli. The reason of this diversity may perhaps be, that the arteries which are so small within the bones as to have no strong contractile propelling force in their coats, and where they are not assisted by the action of any moving neighbouring organ, should have, at least in their passage through the bone, a favourable descent for their liquids.

The lower end of the fibula is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently a scabrous surface, that is received by the external hollow of the tibia, and so firmly joined to it by a very thin intermediate cartilage and strong ligaments, that it scarce can move.

Below this, the fibula is stretched out into a coronoid process, that is smooth, covered with cartilage on its internal side, and is there contiguous to the outside of the first bone of the foot *, the astragalus, to secure the articulation. This process, named *malleolus externus*, being situated farther back than the internal malleolus, and in an oblique direction, obliges us naturally to turn

* Hence luxations of the foot are very rare, and produced only by very great violence, and such luxations are frequently accompanied by a fracture of one of the malleoli. The luxation inwards, is more frequent than the luxation outwards, the malleolus internus being shorter than the malleolus externus.

the fore-part of the foot outwards *. From the lower internal part of the malleolus internus, ligaments are extended to the astragalus, os calcis, and os naviculare, bones of the foot; and from its inside, short strong ones go out to the astragalus. On the back-part of it, a sinuosity is made by the tendons of the peronæi muscles. When the ligament extended over these tendons from the one side of the depression to the other is broke, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the fibula.

The upper end of the fibula is united with the tibia by plain surfaces tipped with cartilage; and at its lower end the cartilage seems to glue the two bones together; not, however, so firmly in young people, but that the motion at the other end of such a long radius is very observable †. In old subjects, I often see the two bones of the leg grown together at their lower ends.

This bone affords origin and insertion to muscles, the direction of which may be a little altered on proper occasions, by its upper part shuffling backwards and forwards. It likewise renders the articulation of the foot more secure and firm. The

* Winslow, Memoires de l'Acad. des Sciences, 1722.

† In a subluxation of the foot, the external malleolus is generally broken, as the connection of the fibula to the tibia is very strong.

ends of the tibia and fibula being larger than their middle, a space is here left, which is filled up with such another ligament as I described, extended between the bones of the fore-arm; and which is also discontinued at its upper part, where the tibialis anticus immediately adheres to the solæus and tibialis posticus; but every where else it gives origin to muscular fibres *.

Both the ends of this bone are cartilaginous in a ripe child, and assume the form of appendices before they are united to its body.

Of the Rotula or Patella.

The ROTULA † is the small flat bone situated at the fore-part of the joint of the knee. Its shape resembles the common figure of the heart with its point downwards. The anterior convex of the rotula is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it enter.

Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest;

* WEITBRECHT, Syndesmolog. p. 156.

† Ἐπιμυλὶς μυλακρὶς, κόγχος, ἐπιγονατὶς, πλατυσὶδερον, patella, mola, genu, scuti-forme os, cartilaginosum, disciforme, oculus genu.

and both are exactly adapted to the pulley of the os femoris, on which they are placed in the most ordinary unstraining postures of the leg; but when the leg is much bended, the rotula descends far down on the condyles; and when the leg is fully extended, the rotula rises higher in its upper part than the pulley of the thigh-bone.

The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres: Below, the point of the bone is scabrous, where the strong tendinous ligament from the tubercle of the tibia is fixed.

The upper horizontal part of this bone is flatted and unequal, where the tendons of the extensors of the leg are inserted.

The substance of the rotula is cellular, with very thin external firm plates: But then these cells are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Beside, it is covered with a thick ligament, (as it was observed, that this sort of bones generally is,) to connect its substance, and is moveable to one side or other; therefore is sufficiently strong to resist the ordinary actions of the large muscles that are inserted into it, or any common external force applied to it *; while a fixed process, such as the olecranon, would not have been sufficient to bear the whole weight of our

* Vid. Dr PETER CAMPER's Treatise, De Fractura Patellæ.

bodies, which frequently fall on it, and would have hindered the rotatory motion of the leg. Notwithstanding these precautions to preserve this bone from such injuries, yet I have seen a transverse fracture in it, occasioned by the violent effort of the extensor muscles *, and when the knee had not struck the ground †.

At the ordinary time of birth, the rotula is entirely cartilaginous ‡, and scarcely assumes a bony nature so soon as most epiphyses do.

Of the Movements of the Knee.

The two principal motions are *Flexion* and *Extension*. In the former of these, the leg may be

* Pare, Liv. xv. cap. 22.

† In such fracture, the rotula seems to give way, whilst the knee is in the middle state between flexion and extension; that is, whilst the middle of the rotula is supported on the rough line of the os femoris, as on a fulcrum; in which situation, the weight of the body and the muscles have the advantage of a lever to crack it across, although they were not sufficient by straight traction to draw its parts asunder.

‡ From this circumstance, combined with the greater narrowness of the pelvis, the greater shortness of the necks of the thigh-bones, the want of solidity in the foot, arising from some of the bones which compose it, being in a state of cartilage, the greater proportional bulk and weight of the head, and the weakness of the extensor muscles, it is evident, that an infant cannot maintain its body in the erect posture.

brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made smooth far backwards. In performing this, the rotula is pulled down by the tibia. When the leg is to be extended, the rotula is drawn upwards, and consequently the tibia forwards, by the extensor muscles; which, by means of the protuberant joint, and of this thick bone with its ligament, have in effect the chord, with which they act, fixed to the tibia at a considerable angle, therefore act with advantage; but are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior part of the cross ligament, that the body might be supported by a firm perpendicular column: For at this time the thigh and leg are as little moveable in a rotatory way, or to either side, as if they were one continued bone.

But when the joint is a little bended, the rotula is not tightly braced, and the posterior ligament is relaxed; therefore this bone may be moved a little to either side, or with a small rotation in the superficial cavities of the tibia; which is done by the motion of the external cavity backwards and forwards, the internal serving as a sort of axis*. Seeing then one part of the cross ligament is situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of

* Winslow, Exposition Anatomique du corps humain, Traité des Os secs, § 976.

the thigh outwards, that posterior part of the cross ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almost round, was not that motion confined by the lateral ligaments of this joint, which can yield little.

This rotation of the leg outwards, is of great use to us in crossing our legs, and turning our feet outwards, on several necessary occasions; though it is altogether fit this motion should not be very large, to prevent frequent luxations here. While all these motions are performing, the part of the tibia that moves immediately on the condyles is only so much as is within the cartilaginous rings, which, by the thickness on their outsides, make the cavities of the tibia more horizontal, by raising their external side where the surface of the tibia slants downwards. By this means the motions of this joint are more equal and steady than otherwise they would have been. The cartilages being capable of changing a little their situation, are fit for doing this good office in the different motions and postures of the member, and likewise contribute to make the motions larger and quicker.

Luxations of the knee-joint are very rare, on account of the very large surface of the bones forming the joint of the knee, and the many strong ligaments connecting them.

OF THE FOOT.

THE *foot* is divided, as well as the hand, into three parts, viz. *Tarsus*, *Metatarsus*, and *Toes* * : In the description of which, the several surfaces shall be named, according to their natural situation, viz. the *broad* of the foot, shall be called superior ; the sole, inferior ; the side on which the great-toe is, internal ; that where the little-toe is, external.

The tarsus † consists of seven spongy bones ; to-wit, the *astragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The astragalus is the uppermost of these bones. The os calcis is below the astragalus, and is considerably prominent backwards beyond the other bones of the tarsus, to form the heel. The os naviculare is in the middle of the internal side of the tarsus. The os cuboides is the most external of the row of four bones at the fore-part of the tarsus. The os cuneiforme externum is placed at the inside of the cuboid. The cuneiforme medium is between the external and internal cuneiform bones, and the internal cuneiform is put at the internal side of the foot.

* Dr CAMPER has recommended that the shoes should be wider before, an more accurately adopted to the form of the foot, in order that the toes may have more full play, and may be less cramped.

† Rassetta.

To avoid repetition, in describing the bones, I desire, once for all, to observe, that wherever a ridge is mentioned, without a particular use assigned, a ligament is understood to be fixed to it; or where a spongy rough cavity, depression or fossa is remarked, without naming its use, a ligament is inserted.

Of the Astragalus.

The upper part of the ASTRAGALUS * is formed into a large smooth head †, which is slightly hollowed in the middle; and therefore resembles a superficial pulley, by which it is fitted to the lower end of the tibia.

The internal side of this head is flat and smooth, to play on the internal malleolus. The external side has also such a surface, but larger, for its articulation with the external malleolus. Round the base of this head there is a rough fossa; and, immediately before the head, as also below its internal smooth surface, we find a considerable rough cavity.

The lower surface of the astragalus is divided by an irregular deep rough fossa; which at its internal end is narrow, but gradually widens, as it stretches obliquely outwards and forwards.

* Ἀστράγαλος, Talus, balistæ os, malleolus, chaib, quatrio, os tessaræ, claviculæ, nuciforme.

† Τετράγωνος.

The smooth surface, covered with cartilage, behind this fossa, is large, oblong, extended in the same oblique situation with the fossa, and concave for its conjunction with the os calcis. The back-part of the edge of this cavity is produced into two sharp-pointed rough processes, between which is a depression made by the tendon of the flexor pollicis longus. The lower surface before the fossa is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or shortest, are articulated with the heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the calcaneum to the os scaphoides. Without which ligament, the astragalus could not be sustained, but would be pressed out of its place by the great weight it supports; and the other bones of the tarsus would be separated. Nor would a bone be fit here, because it must have been thicker than could conveniently be allowed; otherwise it would break, and would not prove such an easy bending base, to lessen the shock which is given to the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong smooth head, called by some its process, which is received by the os naviculare. Round the root of this head, especially on the upper surface, a rough fossa may be remarked.

The astragalus is articulated in such a manner with the malleoli, that the foot may be bended and

extended, but can be moved laterally only in a slight degree. When the foot is bended, so far as it is commonly when we stand, no lateral or rotatory motion is allowed in this joint; for then the head of the astragalus is sunk between the malleoli, and the ligaments are tense; but when the foot is extended, the astragalus can move a little to either side, and with a small rotation. By this contrivance, the foot is firm, when the weight of the body is to be supported on it; and when a foot is raised, we are at liberty to direct it more exactly to the place we intend next to step upon. The astragalus is joined, below, to the os calcis; and before, to the os naviculare, in the manner to be explained, when these bones are described.

A considerable share of this bone is ossified in a new-born infant.

Of the Os Calcis.

The CALCANEUM * or OS CALCIS is the largest bone of the seven. Behind, it is formed into a large knob, commonly called the *heel:* The surface of which is rough behind, where the tendo achillis is inserted into it; and above, it is hollow and spongy. Farther forwards, on the upper surface of the calcaneum, there is an irregular oblong smooth convexity, adapted to the concavity at the back-part of

* Os calcis, πτέρνα, calcar pedis.

the astragalus: And beyond this a narrow fossa is seen, which divides it from two small concave smooth surfaces, that are joined to the fore-part of the astragalus. Behind the posterior of these smooth surfaces, which is the largest, a small sinuosity is made by the tendon of the flexor digitorum longus; at the fore-part of which a small rough protuberance appears, that gives rise to the musculus extensor digitorum brevis.

The external side of this bone is flat, with a superficial fossa running horizontally, in which the tendon of the musculus peronæus longus is lodged. The internal side of the heel-bone is hollowed, for lodging the origin of the massa carnea Jac. Sylvii, and for the safe passage of tendons, nerves, and arteries. Under the side of the internal smooth concavity, a particular groove is made by the tendon of the flexor pollicis longus; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the astragalus, goes out to the os naviculare; on which ligament, and on the edge of this bone to which it is fixed, the groove is formed for the tendon of the flexor digitorum profundus.

The lower surface of this bone is pressed flat at the back-part, by the weight of our bodies; and immediately before this plane, there are two tubercles, from the internal of which the musculus abductor pollicis, flexor digitorum sublimis, as also part of the aponeurosis plantaris, and of

the abductor minimi digiti, have their origin; and the other part of the abductor minimi digiti and aponeurosis plantaris rise from the external.

Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which, and a tubercle behind it, the ligament goes out that prevents this bone from being separated from the os cuboides.

The fore-part of the os calcis is formed into an oblong pulley-like smooth surface, which is circular at its upper external end, but is pointed below. This smooth surface is fitted to the os cuboides.

Though the surfaces by which the astragalus and os calcis are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base which rests on the ground, to-wit, the os calcis, firm.

A large share of the heel-bone is ossified at the ordinary time of birth, and the large knob appears afterwards in form of an epiphyse.

Of the Os Naviculare.

The Os NAVICULARE * is somewhat circular. It is formed into an oblong concavity behind for receiving the anterior head of the astragalus. On

* Σκαφοειδὴς, os cymbæ.

the upper surface there is a rough fossa. Below, the os naviculare is very unequal and rough; but hollow for the safety of the muscles. On its inside a large knob rises out, from which the abductor pollicis takes in part its origin, and the tendon of the tibialis posticus is inserted into it: And to it two remarkable ligaments are fixed; the first is the strong one, formerly mentioned, which supports the astragalus; the second is stretched from this bone obliquely across the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one. On the outside of the os naviculare there is a semicircular smooth surface, where it is joined to the os cuboides. The fore-part of this bone is all covered with cartilage, and is divided into three smooth planes, fitted to the three ossa cuneiformia.

The os naviculare and astragalus are joined as a ball and socket, and the naviculare moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, though the motions are greatly restrained by the ligaments which connect this to the other bones of the tarsus. A weakness of these ligaments causes sometimes an unnatural turn of the fore-part of the foot inwards *.

The os naviculare is wholly cartilaginous in a new-born infant.

* The deformity in cases of club-foot is chiefly owing to the distortion of the os naviculare.

Of the Os Cuboides.

The Os Cuboides* is a very irregular cube. Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the os calcis. There is a small semicircular smooth cavity on the inner side of this bone, where it is joined to the os naviculare; immediately before which, an oblong smooth plane is made by the os cuneiforme externum. Below this, the bone is hollow and rough. On the internal side of the lower surface, a round protuberance and fossa are found, where the musculus adductor pollicis has its origin. On the external side of this same surface, there is a round knob, covered with cartilage; immediately before which, a smooth fossa may be observed, in which the tendon of the peronæus primus runs obliquely cross the foot; and on the knob, the thin flat cartilage proper to this muscle plays; in place of which sometimes a bone is found: More externally than the knob, a rough hollow is made, for the strong ligaments stretched betwixt this bone and the os calcis. Before, the surface of the os cuboides is flat, smooth, and slightly divided into two planes, for sustaining the os metatarsi of the little toe, and of the toe next to it.

* Πολύμορφον, cubiforme, quadratum, grandinosum, varium, tessaræ, multiforme.

The form of the back-part of the os cuboides, and the ligaments connecting the joint there with the os calcis, both concur in allowing little motion in this part *.

The ossification of this bone is scarcely begun at birth.

Of the Os Cuneiforme Externum.

The Os CUNEIFORME EXTERNUM †, if we regard its situation or medium by its bulk, is much of the shape of a wedge, being broad and flat above, with long sides running obliquely downwards, and terminating in a sharp edge. The upper surface of this bone is an oblong square. The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the os naviculare. The external side is an oblong square divided as it were by a diagonal; the upper half of it is smooth, for its conjunction with the os cuboides: The other is a scabrous hollow, and in its superior anterior angle, a small smooth impression is made by the os metatarsi of the toe next to the little one. The internal side of this bone is also quadrangular, with the fore-part of its edge made flat

* If a weight bears on an arch, that arch is either supported at the sides, or these sides are joined together. It is in the latter way that this joint is secured.

When this ligament is sprained or torn, it generally brings on a tedious or incurable lameness.

† Chalcoïdeum externum.

and smooth by the os metatarsi of the toe next to the great one, and the back-part is also flat and smooth where the os cuneiforme medium is contiguous to it. The fore-part of this bone is an oblong triangle, for sustaining the os metatarsi of the middle toe.

Of the Os Cuneiforme Medium.

The Os Cuneiforme Medium, *or* Minimum, is still more exactly the shape of a wedge, than the former. Its upper part is square;—its internal side has a flat smooth surface above and behind, for its conjunction with the following bone; with a small rough fossa below; and a considerable share of it is rough and hollow. The external side is smooth and a little hollowed, where it is contiguous to the last described bone. Behind, this bone is triangular, where it is articulated with the os naviculare; and it is also triangular at its fore-part, where it is contiguous to the os metatarsi of the toe next to the great one.

Of the Os Cuneiforme Internum.

The Os Cuneiforme Maximum, *or* Internum, differs from the two former in its situation, which is more oblique than theirs. Besides, its broad thick part is placed below, and the small thin point is above and outwards; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe. The surface of this os

cuneiforme behind, where it is joined to the os naviculare, is hollow, smooth, and of a circular figure below, but pointed above. The external side consists of two smooth and flat surfaces, whose direction is nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the os cuneiforme minimum is joined; and with the anterior, whose direction is longitudinal, the os metatarsi of the toe next to the great one is connected. The forepart of this bone is semilunar, but flat and smooth, for sustaining the os metatarsi of the great toe. The internal side is scabrous, with two remarkable tubercles below, from which the musculus abductor pollicis rises; and the tibialis anticus is inserted into its upper part.

The three cuneiform bones are all so secured by ligaments, that very little motion is allowed in any of them, and they are cartilaginous in a fœtus of nine months.

These seven bones of the tarsus, when joined, are convex above, and concave below; thus the several muscles, tendons, and vessels, that lie in the sole of the foot, are safely lodged. And in the recent subject, their upper and lower surfaces are covered, and strongly united by other strong ligaments. Notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent too

great a shock of the fabric of the body in walking, leaping, &c., by falling on too solid a base; which, if it was one continued bone, would likewise be much more liable to be broken; and, in order to make our foot accommodate itself to the surfaces we tread on, by becoming more or less hollow, or by raising or depressing either side of it, as might be judged by what was said of the particular bones.

Sprains here occasion, as in the wrist, great pain and obstinate tumors, which too often cause carious bones.

Of the Metatarsus.

The METATARSUS *, is composed of five bones, which, in their general characters, agree with the metacarpal bones; but may be distinguished from them by the following marks: 1. They are longer, thicker, and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above, and flatter on the sides, with their inferior ridge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is easily distinguished from the rest by its thickness. The

* Στῆθος, πεδίον, Planta, planum, vestigium, solium, pectus, præcordium, pectusculum.

one next to it is the longest, and with its sharp edge almost perpendicular. The others are shorter and more oblique, as their situation is more external. Which general remarks, with the description I am now to give of each, may teach us to distinguish them from each other.

The os metatarsi pollicis, is by far the thickest and strongest, as having much the greatest weight to sustain. Its base is oblong, irregularly concave, and of a semilunar figure, to be adapted to the os cuneiforme maximum. The inferior edge of this base is a little prominent and rough, where the tendon of the peronæus primus muscle is inserted. On its outside an oblique circular depression is made by the second metatarsal bone. Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the ossa sesamoidea; and on the external side, a depression is made by the following bone.

The os metatarsi of the second toe, is the longest of the five, with a triangular base supported by the os cuneiforme medium, and the external side produced into a process; the end of which is an oblique smooth plane, joined to the os cuneiforme externum. Near the internal edge of the base, this bone has two small depressions, made by the os cuneiforme maximum, between which is a rough cavity. Farther forwards, we may observe a smooth protuberance, which is joined to the foregoing bone. On the outside of the base are two oblong smooth surfaces, for its articulation

with the following bone; the superior smooth surface being extended longitudinally, and the inferior perpendicularly; between which, there is a rough fossa.

The os metatarsi of the middle toe, is the second in length. Its base, supported by the os cuneiforme externum, is triangular, but slanting outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage but of a different figure; for the upper one is concave, and, being round behind, turns smaller as it advances forwards; and the lower surface is little, smooth, convex, and very near the edge of the base.

The os metatarsi of the fourth toe, is nearly as long as the former, with a triangular slanting base joined to the os cuboides, and made round at its external angle, having one hollow smooth surface on the outside, where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which, is a long narrow surface impressed by the os cuneiforme externum.

The os metatarsi of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally. The base of it, part of which rests on the os cuboides, is very large,

tuberous, and produced into a long pointed process externally, where part of the abductor minimi digiti is fixed; and into its upper part, the peronæus secundus is inserted. Its inside has a flat conoidal surface, where it is contiguous to the preceding bone.

When we stand, the fore ends of these metatarsal bones, and the os calcis, are our only supporters; and therefore it is necessary they should be strong, and should have a confined motion.

Of the Toes.

The bones of the Toes are much a-kin to those of the thumb and fingers: Particularly the two of the great toe are precisely formed as the two of the thumb; only their position, in respect of the other toes, is not oblique; and they are proportionally much stronger, because they are subjected to a greater force; for they sustain the force with which our bodies are pushed forwards by the foot behind at every step we make; and on them principally the weight of the body is supported, when we are raised on our tiptoes.

The three bones in each of the other four toes, differ from those of the fingers, in these particulars. They are less, and smaller in proportion to their lengths: Their bases are much larger than their anterior ends: Their bodies

are more narrow above and below, and flatter on the sides. The first phalanx is proportionally much longer than the bones of the second and third, which are very short.

Of the four, the toe next to the great one, has the largest bones in all dimensions, and more externally the toes are less. The little toe, and frequently that next to it, have the second and third bones intimately united into one; which may be owing to their little motion, and the great pressure they are subjected to.

The toes are of good use to us in walking; for, when the sole is raised, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The bones of the metatarsus and toes, are in the same condition in children as those of the metacarpus and fingers.

The only bones remaining to be described, are the small ones, which are found at the origin of the gastronemi muscles, at the 1st and 2d joints of the great toe, and at the joint of the thumb and fingers, called,

Ossa Sesamoidea.

The Ossa Sesamoidea, are of very different figures and sizes, and are generally said to resemble the seed of the *sesamum*. Their

number, figure, situation, and magnitude, are uncertain, that it were in vain to insist on the differences of each.

The sesamoid bones at the first joint of the great toe are much larger than any other, are early formed, and are seldom wanting in an adult. These bones, by increasing the angle of insertion of the tendons of the flexor muscles, add considerably to the force of these muscles; and they may possibly tend to prevent the above tendons from being compressed by the weight of the body *.

* That the sesamoid bones are not formed in consequence of pressure, is evident, as in the fœtus a few months after conception, there are cartilages of a similar figure as the sesamoid bones.

CHAPTER II.

MUSCLES OF THE PELVIS AND INFERIOR EXTREMITIES.

SECT. I.

MUSCLE OF THE PELVIS.

ILIO-COSTALIS, or *Quadratus Lumborum.*

THIS muscle takes its origin from the lateral and posterior half of the spine of the os ilium, between the origins of the psoas magnus, and transversalis abdominis, and it is inserted into the transverse processes of the lumbar vertebræ, and into the posterior part of the last rib, and into the side of the last vertebræ of the back.

By this muscle, the last rib is pulled down, as in difficult expiration, and when the muscles of both sides are at the same time thrown into action, the loins are bent.

Sect. II.

OF THE TENDINOUS APONEUROSIS OF THE INFERIOR EXTREMITY, AND MUSCLE PROPER TO IT.

At present it is proposed to describe in very general terms the tendinous aponeurosis of the inferior extremity.

The fascia of the thigh, which has been called *fascia lata*, is made up partly of tendinous, and partly of ligamentous fibres.

It is smooth on its external surface, and considerably thicker on the outer than on the inner side of the thigh, and it not only covers, but also enters between the muscles of the thigh.

The upper part of this fascia, which is very intimately interwoven with the crural arch, (in a manner to be afterwards more fully described), is covered by a very thin tendinous fascia, called the *glandular fascia.*

The large vein, called *vena saphana major*, runs between the fascia lata and the skin, and sinks beneath *a crescent-like fold of fascia*, to join the deep femoral vein.

There are many small nerves which ramify above this fascia of the thigh, which are derived from the *lumbar* and *anterior crural nerve;* and also a number of lymphatic glands, and lymphatic

vessels which appear like lines of a whitish colour, and enter the inguinal lymphatic glands, at the upper and inner part of the thigh.

This fascia is connected to the crural arch, with the sacro-sciatic ligaments, if the tendons of the glutæus maximus, and tensor vaginæ femoris, with the linea aspera, condyles of the thigh-bone, and patella, and is attached also to the upper parts of the tibia and fibula, and being continued, forms the fascia of the leg.

The fascia of the leg is connected to every projecting part of the bones, becoming thinner towards the under part of the leg, and where it passes over the ancle. It forms a strong *annular* or *transverse ligament*, which extends from the outer ancle and neighbouring part of the os calcis, and is fixed to the malleolus internus, and os naviculare. This ligament binds down the tendons of the extensor muscles.

There is a muscle proper to the upper part of the fascia, called

Ilio-Femoralis, or *Tensor Vaginæ Femoris.*

This muscle arises from the external part of the anterior superior spinous process of the os ilium, and is fixed into the fascia, where it covers the upper and outer side of the thigh, a little below the trochanter major.

The use of this muscle is, to stretch the fascia, and to assist in the abduction of the thigh.

The tendinous fascia of the sole of the foot, which is very thick and strong, extends between the prominent and anterior part of the os calcis, and to the heads of the metatarsal bones, to which it is fixed by its bifurcated extremities, between which the tendons of the flexor muscles pass.

Sect. III.

MUSCLES INSERTED INTO THE TROCHANTER MAJOR.

The muscles inserted into the trochanter major, move the thigh-bone within the acetabulum, in such a manner, as to turn the toes outwards, or in the contrary direction.

Sacro-Femoralis, or *Glutæus Maximus.*

This very thick and strong muscle, takes its origin from the posterior edge of the os ilium, from the lateral surface of the os sacrum, and from the posterior part of the sacro-sciatic ligaments, and is fixed into the posterior part of the thigh-bone, below the great trochanter, and into the fascia lata of the thigh.

By this muscle, the ball of the os femoris is rotated outwards.

This is one of the most powerful muscles, by which the body is kept erect.

ILIO-TROCHANTERUS MAJOR, or *Glutæus Medius.*

This muscle arises from the circumference and outer edge of the dorsum of the os ilium, and its radiated fibres are collected and inserted into the upper part of the trochanter.

By the above muscle, the thigh is rotated outwards.

ILIO-TROCHANTERUS MINOR, or *Glutæus Minimus.*

This muscle arises from the anterior and inferior part of the os ilium; the fibres of the muscle run in a radiated manner, and are inserted by a thin and broad tendon, into the anterior and superior part of the trochanter major.

The four following muscles turn the thigh on its axis from within outwards.

SACRO-TROCHANTERUS, or *Pyriformis.*

This muscle arises from the inner side of the 2d, 3d, and 4th pieces of the os sacrum; and passes out of the pelvis above the upper sacro-sciatic ligament, and is fixed by a strong round tendon, into the top of the great trochanter.

This muscle is covered by the glutæus maximus, and medius muscles.

SUB-PUBO-TROCHANTERUS, or *Obturator Internus.*

This muscle extends between the internal part of the membrane, which fills up the foramen obturatorium, and the great trochanter, and its tendon passes over, and revolves upon the posterior edge of the ischium, between the two following muscles.

ISCHII-TROCHANTERI, or *Gemini.*

These muscles which lie below the pyriform muscle, take their origins from the posterior edge of the ischium, and are inserted into the top of the great trochanter.

ISCHIO-TROCHANTERUS, or *Quadratus Femoris.*

This muscle, which is placed under the preceding, extends between the tuberosity of the os ischium, and posterior edge of the great trochanter, rotates the thigh from within outwardly.

SECT. IV.

THE MUSCLES INSERTED INTO THE TROCHANTER MINOR, WHICH ARE FLEXORS OF THE THIGH.

PRÆ-LUMBO-TROCHANTERUS, or *Psoas Magnus.*

THIS muscle arises from the sides of the transverse processes of the lumbar and last dorsal ver-

tebra, it passes along the brim of the pelvis, and and is inserted into the lesser trochanter.

ILIO-TROCHANTINUS, or *Iliacus Internus.*

This muscle takes its origin from the transverse process of the lowest lumbar vertebra, and also from the inner surface of the os ilium; it passes along the brim of the pelvis, and is fixed, along with the former muscle, into the lesser trochanter.

This muscle is covered by a strong fascia, which is fixed into the posterior part of the crural arch; and a part of the fascia is continued behind the femoral vessels, and forms the posterior part of the crural sheath.

PUBO-FEMORALIS, or *Pectinalis.*

This muscle which arises from the superior margin of the os pubis, and forms a part of the brim of the pelvis, is fixed by a thin tendon into the trochanter minor, and linea aspera below it.

The following muscles draw the thighs inwards, and towards each other.

SUB-PUBO, SUB-PUBI, ISCHII-FEMORALES, or *Triceps Adductor Femoris.*

The first portion arises from the symphysis pubis; the second from the descending branch of the os pubis; and the third from the tuberosity of the ischium.

These muscles are fixed into the whole length of the linea aspera.

The three last muscles are counteracted by the

SUB-PUBO-TROCHANTERUS EXTERNUS, or *Obturatur Externus*,

This muscle, which covers the foramen obturatorium, arises from the edge of the obturator hole, and is fixed into the trochanter major.

SECT. V.

MUSCLES OF THE LEG.

THE leg is extended by four muscles, which are inserted into the patella or rotula by a common tendon.

ILIO-ROTULARIS, or *Rectus Anterior Cruris* *.

This muscle arises from the inferior and anterior spinous process of the os ilium, and from the capsular ligament of the joint, and extends along the whole anterior part of the thigh.

This penniform muscle, is fixed into the upper extremity of the patella.

The three other *extensors of the leg* have been described by some authors under the name *Trifemoralis.*

* Vid. Plate 2. fig. 3.

MIDDLE OF THE TRIFEMORO-ROTULARIS, or *Cruralis.*

This muscle, which is situated under the preceding muscle, arises from the whole anterior surface of the thigh-bone, and is fixed into the posterior surface of the tendon of the rectus muscle.

OUTER SHARE OF THE TRIFEMORO-ROTULARIS, or *Vastus Externus.*

This muscle, which occupies the outer side of the thigh-bone, arises from the anterior surface of the root of the trochanter major, and from the outer edge of the linea aspera, and is inserted into the external surface of the tendon of the rectus cruris.

INNER SHARE OF THE TRIFEMORO-ROTULARIS, or *Vastus Internus.*

This muscle fills up the inner part of the thigh-bone, and arises from the root of the trochanter minor, from the upper edge of the linea aspera, and from the whole internal surface of the thigh-bone, and it is inserted into the lateral surface of the tendon of the rectus cruris.

The above muscles are counteracted by the six following strong *flexor muscles.*

ISCHIO-PERONEUS, or *Biceps Flexor Cruris.*

This muscle consists of two parts; the longer is derived from the outer part of the tuberosity of the os ischium, and the other from the middle of the linea aspera of the os femoris: below the insertion of the glutæus maximus, both parts unite, and are fixed into the outer part of the head of the fibula.

ISCHIO-SUB-TIBIALIS, or *Semimembranosus.*

This muscle takes its rise from the upper and outer parts of the tuberosity of the os ischium, and the fibres are connected to a flat tendon, which is inserted into the upper and inner side of the tibia.

This is a semipenniform muscle.

ISCHIO-PRÆTIBIALIS, or *Semitendinosus.*

This muscle also arises from the tuberosity of the os ischium, and it is inserted into the upper and inner part of the tibia.

The leg is not only bent backwards, but also inwards by this muscle.

ILIO-PRÆ-TIBIALIS, or *Sartorius* *.

This muscle arises from the anterior and superior spinous process of the os ileum, between the

* Vid. Plate 2. fig. 1.

crural arch and tensor vaginalis femoris, and passes for some way upon the rectus cruris, then over the vastus internus, then over the triceps and adductor magnus, or in a spiral direction over the fore-part of the thigh, it passes behind the inner condyle of the thigh-bone, and is inserted into the upper and inner part of the tibia by a broad thin tendon, immediately below the anterior tubercle of the tibia above the tendons of the gracilis and semitendinosus *.

By this muscle, the leg is bent obliquely inwards on the thigh.

Pubo-Pretibialis, or *Gracilis*.

This muscle arises from the lower part of the symphysis pubis, and descends along the inner side of the thigh, and is inserted into the tibia below the sartorius muscle.

The use of this muscle is to assist in the flexion of the knee, after it has been bent by the flexors of the leg.

Poplito-Tibialis, or *Popliteus*.

This muscle extends between the external condyle of the thigh-bone, the back part of the capsular ligament of the joint, and the internal and upper part of the tibia.

By this muscle, the leg is not only bent; but when bent, it is rolled inwards.

* Vid. Plate 2. fig. 1.

Sect. VI.

MUSCLES OF THE ANCLE OR TARSUS, AND OF THE METATARSUS.

The muscles which move the foot, may be divided into three classes :

1. Those which bend the foot.
2. Those which extend the foot by the medium of the tendo Achillis, and are the principal agents in walking, running, dancing, &c.
3. Those which lift the foot to either side.

The flexion of the foot with respect to the leg, or of the leg with respect to the foot, is accomplished by two muscles.

Tibio-super-Tarseus, or *Tibialis Anticus.*

This muscle arises from the fore-part of the tibia, and from the interosseous ligament, and its tendon passes below the annular ligament over the astragalus and os naviculare, and is fixed into the os cuneiforme internum and metatarsal bone of the great toe.

Tibio-sub-Tarseus, or *Tibialis Posticus.*

This muscle takes its origin from the posterior surface of the tibia, fibula, and interosseous ligament ; and its fibres are disposed obliquely in respect to a middle tendon, which passes behind the inner

ancle through a groove in the tibia, and fixed into the os naviculare.

By this muscle, the inner side of the foot is raised.

Of the Muscles which arise from the Perone, or Fibula.

PERONEO-TARSEUS, or *Peroneus Longus.*

This muscle arises from the fore-part of the head of the fibula, and from the outer-part of the same bone.

The muscular fibres are fixed into the tendon, like the plumage of a pen into its stalk. The tendon of this muscle is lodged in a groove, formed by the malleolus externus; it passes across the sole of the foot in a groove in the cuboid bone, and is fixed into the outside of the metatarsal bone of the great toe, and os cuneiforme internum.

By this muscle, the foot is extended, and the inner edge of it turned downwards.

PERONEO-METATARSEUS MAGNUS, or *Peroneus Brevis.*

This muscle takes its rise from the outer part of the fibula, and its tendon passes behind the outer ancle, in the same sheath with the preceding muscle, and is fixed into the external part of the metatarsal bone of the little toe.

The use of this muscle is to pull the outer edge of the foot upwards.

By the weight of the body, the leg is bent forwards on the foot; to obviate which, there are *three very powerful extensor muscles* which compose the calf of the leg, and which act upon the foot by the medium of the tendo Achillis.

Bi-Femoralis Calcaneus, or *Gastrocnemius.*

This muscle consists of two strong heads, which are connected with the upper and back parts of the condyles of the thigh-bone; a little below, the fleshy bellies are united in a middle tendon, which is joined to that of the following muscle.

Tibio-Calcaneus, or *Soleus.*

This compound penniform muscle* rises from the posterior and upper surface of the tibia and fibula. The flesh of this muscle is covered by the tendon of the former muscle.

Femori-Calcaneus, or *the Plantaris.*

This muscle arises from the upper and back part of the external condyle of the thigh-bone, and from the capsular ligament of the joint.

From the muscle, a thin tendon descends between the inner heads of the gastrocnemii muscles, which is fixed into the inner edge of the tendo Achillis, and into the posterior part of the os calcis.

* Vid. Plate 2.

Sect. VII.

MUSCLES OF THE TOES.

There are extensor, flexor, abductor and adductor muscles proper to the toes.

There are three extensor muscles of the toes.

Peroneo-Super-Unguialis, or *the Extensor Longus Digitorum Pedis.*

This muscle takes its rise from the outer part of the head of the tibia, from the fibula and from the interosseous ligament; and below the middle of the leg, it splits into four tendons, which in their course pass under the annular ligament, and are inserted into the root of the first phalanx of each of the four small toes, and are expanded over the upper side of the toes as far as the last phalanx.

Calcaneo-Super-Unguialis, or *Extensor Brevis Digitorum Pedis.*

This muscle arises from the upper and anterior part of the os calcis, from the os cuboides and astragalus; it then divides into four distinct muscles, which are inserted into the first phalanx of the great toe, and into all the other toes excepting the little toe.

PERONEO-SUPER-UNGUIALIS, or *Extensor Longus Pollicis Pedis.*

This muscle arises from the fibula and interosseous ligament; the tendon of this muscle passes over the fore-part of the astragalus and os naviculare, and is fixed into the base of the first and second phalanges of the great toe.

This muscle not only extends the great toe, but also bends the ancle.

There are also *three flexor muscles* of the toes.

TIBIO-SUBUNGUIALIS, or *Flexor Longus Digitorum Pedis.*

This muscle arises from the posterior and flattened portion of the tibia; below the *soleus muscle,* the fibres pass obliquely into a tendon which is situated on the posterior edge of the muscle. The tendon is lodged within a groove behind the inner ancle, and bound down by a strong ligament.

This muscle divides in the sole of the foot into four tendons, (which pass through slits in the tendons of the flexor digitorum brevis), and which are inserted into the last joint of the lesser toes.

By this muscle, all the joints are bent, but chiefly the last joint.

FLEXOR DIGITORUM ACCESSORIUS, or *Massa Carnea Sylvii.*

This muscle, which is connected by two portions to the os calcis, and is fixed into the tendons

of the preceding muscle; assists in bending the toes.

PLANTO-SUB-PHALANGEUS, or *Lumbricales.*

The lumbricales are four thin portions of muscles, which are fixed to the tendons of the flexor profundus, the inside of the first joint of the four small toes, and the tendinous expansion which is derived from the extensor muscles which covers the upper part of the toes.

These muscles increase the extent of the flexion of the toes.

CALCANEO-SUB-UNGUIALIS, or *Flexor Brevis Digitorum Pedis Perforatus.*

This short flexor muscle arises from the inferior and anterior part of the os calcis, and from the aponeurosis plantaris, it splits into four small tendons, which give passage to the tendons of the long flexor; and are then fixed into the second phalanx of the four small toes.

Besides the muscles enumerated in the preceding pages, the following are proper to the great and little toes, viz. calco-sub-phalangeus, or the abductor pollicis; metatarso-sub-phalangeus-transversalis-pedis, or transversalis pedis; metatarso-

sub-phalangeus-pollicis, or adductor pollicis; tarso-phalangeus, or flexor longus pollicis pedis; tarso-sub-phalangeus-pollicis, or flexor brevis pollicis; calco-sub-phalangeus-minimi-digiti, or abductor minimi digiti; tarso-sub-phalangeus-minimi-digiti, or flexor brevis minimi digiti.

Tarso-Phalangeus, or *Flexor Longus Pollicis Pedis.*

This muscle, which bends the great toe, arises from the posterior part of the fibula; and the tendon of the muscle passes through a groove in the tibia, then through a groove in the astragalus, crosses the sole of the foot, and is inserted into the last joint of the great toe.

Calco-Sub-Phalangeus-Pollicis, or *Abductor Pollicis Pedis.*

This muscle takes its rise from the lower and inner part of the heel-bone, and from that bone by a tendon, where it joins with the os naviculare, and is inserted into the os sesamoideum internum, and root of the first joint of the great toe.

By this muscle, the great toe is pulled from the others.

METATARSO-SUB-PHALANGEUS-TRANSVERSALIS POLLICIS, or *Transversalis Pedis.*

This muscle takes its rise from the metatarsal bone of the little toe; crosses over the anterior extremities of the other metatarsal bones; and is inserted into the fore-part of the metatarsal bone of the great toe, and into the internal sesamoid bone.

By this muscle, the foot is made narrower, the outer and inner toes being drawn towards each other.

METATARSO-SUB-PHALANGEUS POLLICIS, or *Adductor Pollicis.*

This muscle takes its origin by a long tendon from the under part of the os calcis, os cuboides and os cuneiforme externum, and root of the metatarsal bone of the second toe; it is divided into two portions, which are inserted into the external os sesamoideum, and root of the metatarsal bone of the great toe.

By this muscle, the great toe is pulled towards the other toes.

TARSO-SUB-PHALANGEUS POLLICIS, or *Flexor Brevis Pollicis.*

This muscle extends between the fore under part of the os calcis, and the external sesamoid bone, and root of the first bone of the great toe.

By this muscle, the first joint of the great toe is bent.

CALCO-SUB-PHALANGEUS MINIMI DIGITI, or *Abductor Minimi Digiti.*

This muscle extends between the under protuberance of the os calcis, the root of the metatarsal bone of the little toe, and the outer part of the root of the first bone of the little toe.

By this muscle, the little toe is drawn outwards.

TARSO-SUB-PHALANGEUS MINIMI DIGITI, or *Flexor Brevis Minimi Digiti.*

This muscle extends between the cuboid bone, the outer and back part of the matatarsal bone of the little toe, and the anterior extremity of the metatarsal bone, and root of the first bone of the little toe.

This muscle assists in bending the little toe.

In the foot, there are also two strata of interossei muscles, viz. three *interossei interni*, placed in the sole of the foot, which move the three lesser toes towards each other. There are four *interossei externi*, which are larger than the internal, and bicipites, which separate the toes from each other.

CHAPTER III.

OF THE BURSAE OF THE INFERIOR EXTREMITIES.

THE *Bursæ Mucosæ*, which appear in a fore view of the inferior extremity, are,

A *very large bursa mucosa* between the iliacus internus and psoas muscles, and the capsular ligament of the thigh-bone.

There is a *bursa* between the tendon of the pectineus and thigh-bone.

And also a small *bursa mucosa* between the glutæus medius and trochanter major; and behind it, the tendon of the pyriformis is inserted.

There is a *bursa mucosa* between the tendon of the glutæus minimus and trochanter major.

There is a *bursa mucosa* between the glutæus maximus and vastus externus.

There is a *large bursa mucosa* behind the tendon of the extensors of the leg.

There is a *bursa mucosa* behind the ligament, which joins the patella to the tibia; and a large fatty peloton hangs down into the cavity of the bursa.

There is a *large bursa mucosa* behind the tendon of the sartorius, and behind the tendons of the gracilis and semitendinosus, covering the inner fore-part of the tibia.

There is a *bursa mucosa* between the tendon of the tibialis anticus, and under part of the tibia and ligament of the ankle.

There is a *bursa mucosa* between the tendon of the extensor pollicis pedis longus, and the tibia and ligament of the ankle.

There is a *bursa mucosa* for the tendons of the extensor digitorum communis longus, between them and the tibia and ligament of the ankle.

Bursæ Mucosæ in the Vicinity of the Knee-Joint.

There is a *large bursa mucosa*, placed between the tendons of the extensores cruris, and the fore-part of the thigh-bone, which is separated by a partition from the cavity of the joint of the knee, by the membrane of the bursa and inner layer of the capsular ligament, joined together by cellular substance.

There is a *bursa* between the ligament which joins the patella to the tubercle of the tibia, and the upper fore-part of the tibia.

The Bursæ Mucosæ which appear in the Back-View of the Inferior Extremity.

THERE is a *bursa mucosa* between the glutæus medius and pyriformis.

There is a *bursa mucosa* between the obturator and os ischium.

An *oblong bursa mucosa* occurs between the obturator internus, gemini, and capsular ligament of the thigh-bone.

There is a *large bursa mucosa* between the tendon of the glutæus maximus and root of the trochanter major.

There are *two small bursæ mucosæ* between the tendon of the glutæus maximus and thigh-bone.

A *bursa mucosa* occurs between the tendons of the semimembranosus, and gemellus and the ligament of the knee.

A *small bursa* is placed within the bursa, from which there is a passage into the cavity of the joint of the knee.

There is a *bursa mucosa* between the inner side of the tendon of the semimembranosus and the lateral internal ligament of the knee, from which there is a passage making a communication with the joint of the knee.

A *bursa* is placed under the popliteus muscle, which frequently communicates with the cavity of the joint of the knee.

There is a *large bursa mucosa* common to the tendons of the peronei muscles.

A *bursa* is proper to the tendon of the peroneus brevis.

A *bursa mucosa* is placed between the tendo Achillis and the os calcis; and there is a peloton of fat, which projects into the cavity of the bursa.

A *bursa mucosa* intervenes between the flexor pollicis longus and the os calcis.

There is a *bursa* between the flexor digitorum longus communis, and the tibia and os calcis.

A *bursa* is placed between the tendon of the tibialis posticus, and the tibia and astragalus.

Bursæ Mucosæ in the Sole of the Foot.

There is a second *bursa mucosa* for the tendon of the peroneus longus.

There is a *bursa mucosa* common to this tendon, and the tendon of the flexor digitorum pedis communis longus profundus.

There are *five bursæ mucosæ* of the flexor tendons, which begin a little above the first joint of the toes, and extend to the root of the third phalanx or insertion of the tendons.

CHAPTER IV.

OF THE LIGAMENTS OF THE PELVIS AND INFERIOR EXTREMITIES.

SECT. I.

OF THE LIGAMENTS OF THE PELVIS.

THE bones of the pelvis are very firmly bound together by ligaments, as the pelvis supports the weight of the trunk of the body, and is also the basis on which the inferior extremities move.

The form of the bones of the pelvis contributes much to the firmness of it.

The os sacrum, from the oblique direction of its articulating surfaces, is like a wedge placed between the ossa innominata; the extremities of each of which bones are arched forwards, and united at the symphysis pubis; hence the greater the depressing power, the more closely the bones of the pelvis are pushed together.

Sect. II.

FRONT VIEW.

The os sacrum is united to the ossa innominata by very strong ligaments, from which there is a ligament which sweep along the upper aperture of the pelvis.

There are small apertures in the above ligament for the passage of the lumbar nerves.

The crural arch is seen extending from the anterior and superior spinous process of the ilium, and with its fibres inserted into the opposite os pubis, a few ligamentous fibres extend downwards from the superior and anterior spinous process of the os ilium, to the inferior and anterior spinous process of the os ilium.

There is a strong capsular ligament at the symphysis pubis, from which there is a round and strong ligament, which descends to the tuberosity of the ischium, which joins with the capsular ligament of the pubis, and is united by a few transverse ligamentous fibres, to a similar ligament of the opposite side.

The obturator foramen is filled up by a ligament, in which there is a large aperture for the obturator artery and nerve, and three other small apertures, from which small branches of the ob-

turator artery vein and nerve pass outwards, and get into the acetabulum, to supply the synovial apparatus within the hip-joint.

The capsular ligament of the thigh-bone, is well seen in this view; it receives some additional ligamentous fibres, the strongest of which arise from the anterior and inferior spinous process of the os ilium, and on its pubal side, some ligamentous fibres, which take their origin from the os pubis.

Sect. III.

BACK VIEW OF THE PELVIS.

There are two ligaments disposed transversely, which unite the os sacrum to the os innominata, besides a general capsular ligament, and there is within the joint a ligament of cellular substance, containing mucus.

There is a long and strong ligament called *ilio-sacral*, which originates from the posterior spinous process of the spine of the os ilium, and descends obliquely into the lower part of the os sacrum.

There is also a shorter ligament which is fixed higher into the os sacrum.

There are also lateral ligaments extending between the os ilium and the ligament which covers the spinous processes of the vertebræ.

The posterior part of the os sacrum is covered by a ligamentous crust, the fibres of which, fol-

low different directions, and which extends along the under part of the bone, to the lower extremity of the ossa coccygis.

There are two *sacro-sciatic ligaments*, the larger extends between the transverse processes of the os sacrum, the under and lateral part of that bone, and the tuberosity of the os ischium, the other, which has a similar origin, is fixed into the spinous process of the os ischium.

There are two membranous appendices connected to the above ligaments, the one increases the breadth of the upper ligament, the other arises within the pelvis, and is fixed to the os ischium.

By the larger external ligament, the large notch in the ilium is converted into a hole for the passage of the pyriform muscle, the great sciatic nerve, and the gluteal arteries.

The muscle called *obturator internus* passes between the sacro-sciatic ligaments.

The large holes in the back part of the os sacrum, are in a great measure filled by ligaments, which project from one tubercle to another, and the back-part of the ossa coccygis is covered by ligaments which pass along these in a longitudinal direction, and which are fixed into the extremity of the last os coccygis *.

* Loder's Plates, xxi. and xxii. which represent the Ligaments of the Pelvis, are very faithful copies of Nature.

Sect. III.

LIGAMENTS OF THE HIP-JOINT.

The acetabulum is lined by a cartilage, which is thinner in its centre than its circumference, and the ball of the thigh-bone is also covered by cartilage, which is thinner in its circumference than its centre.

The capsular ligament of this joint is very strong, especially at the anterior and outer part, but internally it is considerably thinner where it is covered by the iliacus internus muscle.

There are several tendinous slips from the adjacent muscles, which add considerably to the strength of this capsular ligament.

This ligament is fixed to the outer side of the brim of the acetabulum, and incloses not only the head, but also the whole of the neck of the thigh-bone, and the outer part of this ligament extends farther down than the inner, which is reflected upon the neck of the bone *.

There is a ligament within this joint somewhat of a triangular shape, which consists of two parts; one of these is fixed to the under part of the acetabulum, and is connected to the substance, called the *gland* of the joint, from which it becomes gra-

* Vid. August. Frid. Walter, de Articulis, ligamentis et musculis hominis incessu statuque dirigend.

dually narrower, and the other is fixed to the notch in the acetabulum; these parts are united and inserted into the pit, upon the inner surface of the ball of the thigh-bone.

There is a double *cartilago-ligamentous membrane*, stretched across the breach in the inner and fore part of the acetabulum; iu the posterior part of which, there is an aperture for lodging a part of the synovial apparatus, and the bony margin of the acetabulum is encircled by a ligament, which adds considerably to its depth, called the *cotyloid ligament*.

The muscles which surround this joint, also contribute to strengthen it.

Sect. IV.

OF THE SYNOVIAL APPARATUS OF THE HIP-JOINT.

The acetabulum is lined by the synovial membrane, which also covers the synovial apparatus of this joint, which is lodged within the acetabulum, and it is then reflected over the *internal ligament* of the joint, and the cartilage which covers the head of the thigh-bone, and also over the neck of the same bone.

The synovial membrane is very vascular, which is supplied with blood from the smaller branches of the obturator artery *.

* Vid. the synovial apparatus of this joint, represented of its natural size, in fig. 3. of Plate viii. of my Father's Book on the Bursæ Mucosæ, and magnified in fig. 4. of the same Plate.

There are a number of fringes connected with the synovial apparatus, from which the synovia may be squeezed out.

The edges of the synovial apparatus are retained in their situation by small ligamentous fibres.

Sect. V.

OF THE CARTILAGES AND LIGAMENTS OF THE KNEE-JOINT.

The knee-joint is formed by the contact of the condyles of the thigh-bone with the head of the tibia, and back-part of the rotula.

These bones, which are covered by articular cartilages, are kept together by various ligaments.

There is a strong capsular ligament, which is connected to the circumference of the lower end of the thigh-bone, and is fixed to the head of the tibia, and the margin of the articulating surface of the patella, so that the patella forms a part of the capsule of the joint.

This ligament is strengthened by lateral ligaments, which adhere to its outer surface, and also by a tendinous aponeurosis from the tendons of the extensor muscles, and by the general tendinous aponeurosis of the limb.

There are two external lateral ligaments, the longer and stronger extends from the tubercle,

about the external condyle of the thigh-bone, to the head of the fibula, and is covered by the tendon of the biceps; and behind this, there is a shorter and thinner ligament similarly situated.

There is also an internal ligament of considerable breadth, passing between the internal condyle of the thigh-bone, which, becoming broader as it descends, is inserted into the edge of the internal semilunar cartilage, and into the upper and inner part of the head of the tibia; and it is covered at its insertion by the tendons of the gracilis, semitendinosus, and sartorius muscles.

In the back part of the capsular ligament, there are irregular bands of ligamentous fibres, which extend between the condyles of the thigh-bone, and the upper and inner part of the head of the tibia; a few of these fibres, which descend obliquely from the external condyle of the thigh-bone to the tibia, are stronger than the others, and have been said to form the ligamentum posticum of WINSLOW.

There is a ligament connecting the patella to the tuberosity at the upper and fore-part of the tibia; and, in some subjects, there is a strong transverse ligament, which fixes the head of the tibia to that of the fibula.

Upon opening the knee-joint, we meet with ligaments within the joint.

The capsular ligament is reflected, and forms the lateral ligaments, called *alaria externa,* and

interna, by which the synovial apparatus is fixed to the sides of the patella; and this apparatus is also fixed by a ligamentum mucosum, which is continued from the union of the ligamenta alaria, to the cavity of the thigh-bone between its condyles, immediately in front of the anterior crucial ligaments.

There are two ligaments which cross each other, hence named *crucial*, the one of which is fixed to the semilunar shaped notch, between the condyles of the thigh-bones, and to the pit at the fore-part of the protuberance in the middle of the head of the tibia; and the other, which is fixed in a similar manner to the thigh-bone, passes behind the former, and is fixed into a pit behind the above named protuberance.

The head of the tibia is divided by a protuberance of bone, into two parts, each of which is somewhat excavated, and each cavity is rendered deeper by a cartilage, somewhat of the form of a crescent, which surrounds that cavity; which cartilage, in its inner part, is as thin as the blade of a knife; but in its outer part, three or four lines in the thickness; and the thicker part of the cartilage is connected to the capsular ligaments, hence these cartilages scarcely change their places.

The upper surface of each cartilage is concave, the lower nearly flat.

These cartilages are connected to each other at their inner cornua, by a small transverse ligament.

Sect. VI.

LIGAMENTS OF THE PATELLA.

The patella is fixed in its place, by the tendon of the extensor muscles, and by a strong ligament which is inserted into the anterior tuberosity of the tibia.

Sect. VII.

OF THE SYNOVIAL APPARATUS OF THE KNEE-JOINT.

The synovial apparatus of this joint, from its extent, is very conspicuous *.

The synovial membrane covers the condyles of the thigh-bone, it lines the patella, and then passes to the tibia.

A fatty substance conceals the fimbriæ of the synovial apparatus from the naked eye; and hence my Father has published several representations of it, much magnified.

* Vid. Monro on the Bursæ Mucosæ, Plate viii, fig. 5, 6, 9, and 10.; in which this apparatus is seen, of its natural size, and also much magnified.

Sect. VIII.

LIGAMENTS BETWEEN THE TIBIA AND FIBULA.

The upper extremity of the fibula, is connected by a capsular ligament to the outer surface of the tibia, and the bond of union is rendered stronger by the external lateral ligament of the knee-joint, and by the tendon of the biceps flexor cruris, which is fixed to the fibula.

There is a strong *interosseous ligament*, composed of oblique fibres, which extends between the ridge at the back part of the tibia, and the corresponding ridge at the inner side of the fibula.

There is a large aperture in the upper part of the interosseous ligament, where the muscles of the fore and back part of the leg are in contact; and also several apertures, through which various bloodvessels pass to the fore-part of the leg.

There are several ligaments which unite the inferior extremity of the fibula and tibia.

Sect. IX.

LIGAMENTS CONNECTING THE BONES OF THE LEG AND TARSUS.

The capsular ligament, which is fixed to the margin of the articular cavity of the tibia and fibu-

la and astragalus, is very thin, especially before and behind.

It is strengthened, as CALDANI has represented in fig. 6th of his 50th Plate, by an upper and under ligament, passing from the lower and back part of the tibia, to the fibula; by a perpendicular ligament which passes from the malleolus externus, to the os calcis; by an anterior and a posterior ligament, the former of which arises from the anterior part of the malleolus externus, and is fixed to the astragalus, and the latter arises from the posterior part of the malleolus externus, and is fixed to the outer and posterior part of the astragalus.

There is also a ligament which arises from the malleolus internus, the fibres of which follow a radiated course, and are fixed to the astragalus, os calcis, and os naviculare.

Ligaments of the Tarsus.

The astragalus is articulated by two cartilaginous planes to the os calcis.

There are several short irregular ligaments which assist in uniting the above bones.

There are lateral and inferior ligaments, fixing together the os calcis and os cuboides.

The convex articular surface of the astragalus is received by a concave surface of the os navicu-

lare, and three short ligaments for retaining these bones in contact.

Ligaments of the Bones of the Feet.

There are transverse ligaments which unite the os naviculare and cuboides.

There are superior, lateral, and plantar ligaments, which unite the os naviculare and os cuneiforme, and many ligaments uniting the os cuneiforme and os cuboides.

The Cuneiforme bones are united by many dorsal and plantar ligaments.

Sect. X.

LIGAMENTS WHICH CONNECT THE BONES OF THE TARSUS AND METATARSUS, AND THE METATARSAL BONES TO EACH OTHER.

The bones of the metatarsus and tarsus, are united by capsular ligaments, and also by other short ligaments called from their situation, *dorsal*, *plantar*, *lateral*, and from the direction of their fibres, *straight*, *oblique*, and *transverse*.

Sect. XI.

LIGAMENTS OF THE PHALANGES OF THE TOES.

The capsular and lateral ligaments of the phalanges of the toes, are similar to those of the fingers, and the tendons of the extensor and flexor muscles are inclosed within similar sheaths.

As my Grandfather, while describing the bones, has made particular mention of the movements performed by the different joints, I have entirely omitted that branch of the subject.

The limits of these Outlines preclude me from entering into an explanation of the muscles employed in standing, walking, running, jumping, dancing, swimming, and skating, or on the strength of the human muscles.

From the subjoined authors, the reader may obtain much useful information on animal mechanics.

Authors on Animal Mechanics.

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Parent, on Animal Mechanics.
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Bichat, Anat. Descrip. tom. 1.
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Lambert, on Human Strength and its Application. A. Berl. 1776.
Regnier's Dynamometer. Journ. Polyt.
Coulomb, on the Daily Labour of Men. B. Soc. Phil. n. 16. M. Inst. ii. 380. Nicholson, iii. 416.
Buchanan, on Human Labour. Repert. xv. 319.

APPEN-

APPENDIX.

Of the Distinctions between the Male and Female, as to Form of Body.

To complete this Volume, it remains to subj in a very few general observations respecting the peculiarities of the male and female form.

Infants of both sexes bear a strong resemblance to each other in form, delicacy of organization, plumpness, the size of their muscles, quantity of fat between these, gait, and in the tones of voice. But after a few years, when the organs are fully developed, and the body has attained its state of maturity, the Female Frame is very different from that of the more robust Male.

The muscles of the male lose their original softness and rotundity; becoming firmer, larger, and of a more determined figure, in consequence of exertion, which also tends to condense the cellular membrane interposed between them; and from the continued operation of the same cause, the original rotundity at last disappears; the outlines of the muscles, particularly in action, are distinctly seen through the skin, and strongly indicate superior strength, muscular energy, and activity.

The delicate organs of the female (at least in polished society) never acquire the same bulk, the same strength, nor the same rigidity as those of the male; on the con-

trary, they retain their original softness and delicacy of texture; and owing to the greater quantity of fat and cellular substance interposed between the muscles of the female, naturally smaller and rounder than those of the male, they are still less prominent; no rising muscle projects to break the charming roundness of the form; the whole outline of the figure retains its original elegance and softness.

The proportions of the male, according to VITRUVIUS, are as follow:

1st, In a well proportioned man, whose arms are stretched out, the distance between the extremities of the fingers of the right and left hands, should be equal to his height, and his figure, therefore, may be included in a square.

2d, When the legs and arms are moderately extended, the ossa pubis are about the centre of the body; or the ossa pubis form the centre of a circle, the circumference of which, touches the extremities of the fingers and toes.

3d, The distances between the top of the shoulder and symphysis pubis, from the symphysis pubis to the top of the knee-pan, and from thence to the inner ancle, should be equal in a well proportioned man.

The ancient statuaries, divided the body into eight heads, and the face into three parts; five of these parts make the breadth of the loins; three parts or noses, the upper part of the thigh; two, the calf of the leg, and one the ancle.

The female figure was formed about one face shorter than the male.

The female is more different from the male in form, than in stature.

The shoulders of a woman are narrower, (the difference between the Apollo Belvidere, and Venus of Medicis amounting to one-third,) and more finely

rounded and softened than those of a man; in whom the greater breadth, and muscular swelling of the parts, indicate his superior energy and strength: Her chest is more convex; her breasts more elevated and rounded; her abdomen more prominent; her loins longer, and her limbs proportionally shorter; her pelvis is much broader, being adapted to the containing and giving passage to her child; her limbs more rounded and more delicate; her thighs larger, the thigh-bones more distant from one another, and inclining inwards, with a rapid slope as they descend; her legs, instead of swelling abruptly at the calves, taper gradually downwards; her ankles are less marked, and more rounded; and her feet and hands smaller, dimpled, and more finely turned.

It has been already noticed, that the skeleton determines the disposition and proportions of the body; and hence, as there exist so many distinctions in the outline of the softer parts of the male and female, there must be corresponding differences between the skeletons of the sexes.

The female skeleton is smaller in all its dimensions, as well as more slender in regard to the individual bones, than that of the male. Like that of the child, it is by no means so much impressed by the muscles, and the cavities are not so deep; hence the greater smoothness and fewer angles of the female skeleton.

The more remarkable differences in the female skeleton, may be traced, as might have been expected, in the trunk of the body, which may be compared to a pyramid, of which the pelvis forms the basis; whilst in the male, the proportions are reversed, the shoulders being much broader, that part may be considered as the basis.

The female chest is shorter, though deeper; more convex in front, and more distant from the pelvis, the loins being longer.

The shoulders at the same time are carried more backwards, and stand out less from the trunk; hence the breadth of the female shoulders is much less considerable than those of the male.

The breadth and capacity of the pelvis may be regarded as the principal characteristic of the female form.

The female pelvis is larger in all its dimensions than that of the male *.

The ossa innominata are farther expanded laterally; the os sacrum is more turned back; the acetabula are removed to a greater distance; and of course the thighbones are placed more obliquely; and the knees are sometimes, as in the Venus of Medicis, turned a little inwards.

Lastly, The bones of the hands and feet of the female skeleton, like those of the rest of the body, are smaller, than those of the male.

I am anxious that the reader should not rest satisfied with the above attempt to delineate the peculiarities of the female form, but should consult the Grecian Statues, which are well calculated to supply all the imperfections of my description.

Of all countries, Greece was unquestionably the most favourable to the study and practice of sculpture; her artists having frequent opportunities of seeing the human

* In the preceding pages, (234, & 235,) of this volume, the measurements of the female pelvis are given, and the distinctions between the pelves of women of different nations, are fully explained by a figure from an original drawing of the justly celebrated Dr P. Camper, who had devoted much attention to this subject. His memoir *Sur le beau physique*, well merits the attention of the reader. In it he has proved, that when an elliptical area is applied to the male and female body of the same size, the female pelvis extends beyond it, whereas the shoulders are included within that area, but the reverse holds true with respect to the male.

figure in its most perfect form, and in all the variety of graceful attitude and action of its muscles.

The salubrity and genial warmth of the climate, the simplicity of diet and manners; together with the easy and flowing dress, by which no part of the body was confined, were peculiarly favourable to the production and preservation of such bodily conformation, as approaches most nearly to the standard of ideal beauty; besides, the the artists, by the exposure of the human form, and display of muscular action at the Olympic Games, had an opportunity of seeing the finest originals for imitation.

The statuaries of Greece did not fail to profit by such superior means of improvement in their art, and have left to posterity the most perfect models of human skill, in which they have expressed with wonderful truth the peculiarities both of the male and the female form.

That my reader may profit by these, and may more clearly perceive the distinctions between the Male and Female, I have subjoined, from the very accurate and rare *Principi del Designo* of Volpato and Morghen, the measurements of those invaluable remains of antiquity, the *Apollo Belvidere*, *Venus of Medicis*, and *Farnesian Hercules*, the first of which is characterised by Visconti *, as possessing a sublime mixture of dignity, strength and elegance; the second, as being the wonder of art; whilst the large and rising muscles of the third (even though he be represented as resting after the last of his twelve labours, and leaning on his club) communicate an impressive idea of great muscular power.

* Vid. his Description of the Antique Statues in the Louvre.

Les Statues, que nous donnons au public, étant de différens charactères ; et nous voulant donner constamment la même proportion dans les mesures, nous avons divisée la tête des figures en douze parties, et chaçune de ces parties est divisée en six minuts.

L'APOLLON DU BELVIDERE.

A huit Têtes, une Partie, et quatre Minuts de hauteur.

Du commencement de la tête, jusqu' à la racine des cheveux, trois parties.

De la même racine jusqu' aux sourcils, trois parties.

Des sourcils jusqu' à la fin du nez, trois parties.

De la fin du nez jusqu' à tout le menton, trois parties.

De la fin du menton jusqu' à la clavicule de la gorge, cinque parties, un minut.

De la même clavicule jusqu' à la fin de la poitrine, neuf parties, trois minuts, et demi.

De la fin de la poitrine jusqu' à la moitié du nombril, dix parties, cinq minuts, et demi.

De la moitié du nombril jusqu' à la fin du ventre, sept parties, quatre minuts, et demi.

De la fin du ventre jusqu' à la moitié de la rotule du genou, vingt quatre parties.

De la même moitié de la rotule jusqu' au commencement du flanc, vingt huit parties, deux minuts.

De la même rotule jusqu' au flocon du pied, vingt trois parties, trois minuts, et demi.

Du flocon du pied jusqu' à la fin de la figure, c' est à dire, jusqu' en terre, quatre parties, quatre minuts.

La longueur de la plante du pied, quatorze parties, un minut, et demi.

De la clavicule de la gorge au commencement du deltoide, neuf parties.

De la plus grande hauteur du deltoide jusqu' à la fin du bicipite, ou biceps, dixsept parties, et un demi-minut.

De la même fin au commencement de la main, seize parties.

La plus grande largeur de l' anti-bras en face, quatre parties, cinq minuts.

La plus grande largeur du bras en face, cinq parties, trois minuts.

La largeur du pouls du bras en face, trois parties, cinq minuts.

De la clavicule de la gorge jusqu' à la moitié des bouts des tetons, dix parties, quatre minuts, et demi.

Entre un bout et l'autre des tetons, quinze parties.

La plus grande largeur du torse. c'est à dire, un peu plus bas du commencement du torace, dix huit parties, trois minuts.

La moindre largeur du même, c'est à dire, au commencement du flanc, quinze parties, trois minuts.

La plus grande largeur des flancs, seize parties, quatre minuts.

La plus grande largeur d'une trocantera du femur à l' autre, dixsept parties, cinq minuts.

La plus grande largeur de la cuisse en face, neuf parties, deux minuts, et demi.

La plus grande largeur du genou au niveau de la moitié de la rotule, cinq parties, trois minuts, et demi.

La plus grande largeur du gras de la jambe, six parties, trois minuts, et demi.

La largeur d' un malleole à l' autre, quatre parties, un demi-minut.

La moindre largeur du pied, trois parties, trois minuts.

La plus grande largeur de même, cinq parties.

LA VENUS DE MEDICI

A sept Têtes, sept Parties, trois Minuts de hauteur.

Du commencement de la tête jusqu' à la racine des cheveux, trois parties.

De la même racine jusqu' aux sourcils, trois parties.

Des sourcils jusqu' à tout le nez, trois parties.

De la fin du nez jusqu' à tout le menton, trois parties.

De la fin du menton jusqu' à la clavicule de la gorge, quatre parties, trois minuts, et demi.

De la clavicule de la gorge jusqu' à la fin de la poitrine, dix parties, cinq minuts.

De la même poitrine jusqu' à la moitié du nombril, huit parties, trois minuts.

De la moitié du nombril jusqu' à tout le ventre, et commencement des cuisses, onze parties, quatre minuts, et demi.

De la fin du ventre jusqu' à la moitié de la rotule du genou, dix huit parties, deux minuts.

De la moitié de la rotule jusqu' au commencement du flanc, vingt sept parties, trois minuts.

De la même moitié de la rotule jusqu' en terre, vingt cinq parties, trois minuts.

La plus grande hauteur du pied, trois parties, cinq minuts, et demi.

Du col de la jambe jusqu' à la fin des doigts, neuf parties, et un demi-minut.

Du commencement de l' humero jusqu' au cubit, vingt parties, deux minuts.

Du cubit au commencement de la main, quatorze parties.

La plus grande largeur de l' anti-bras, cinq parties.

La plus grande largeur du bras, quatre parties, cinq minuts.

De la clavicule de la gorge au commencement du deltoide, six parties, quatre minuts.

De la même clavicule jusqu' à la moitié des bouts des tetons, dix parties, un demi-minut.

Entre un bout et l' autre des tetons, onze parties, deux minuts.

La largeur du torse au niveau de la fin de la poitrine, quinze parties, quatre minuts, et demi.

La moindre largeur du meme, c'est à dire au commencement des flancs, quinze parties, un minut.

La plus grande largeur du même à la fin des flancs, dix sept parties, cinq minuts.

La largeur d' une trocantera du femur à l' autre, dix-neuf parties, trois minuts.

La plus grande largeur de la cuisse, neuf parties, cinq minuts.

La plus grande largeur du genou, six parties.

La plus grande largeur du gras de la jambe, six parties, trois minuts, et demi.

La largeur d' un malleole à l' autre, quatre parties.

La moindre largeur du pied, trois parties, trois minuts, et demi.

La plus grande largeur du même pied, cinq parties, un minut.

L'ERCULE FARNESE

A huit Têtes, trois Parties, trois Minuts et demi de hauteur.

Du commencement de la tête jusqu' à la racine des cheveux, trois parties.

De la même racine jusqu' aux sourcils, c' est à dire, au commencement du nez, trois parties.

Des sourcils, jusqu' à la fin du nez, trois parties.

De la fin du nez, jusqu' à la fin du menton, trois parties.

De la fin du menton, jusqu' à la clavicule de la gorge, six parties.

De la clavicule jusqu' à la fin de la poitrine, neuf parties, quatre minuts.

De la fin de la poitrine jusqu' à la moitié du nombril, dix parties, quatre minuts.

De la moitié du nombril jusqu' à la fin du ventre, huit parties, deux minuts.

De la fin du ventre jusqu' à la moitié de la rotule du genou, vingt trois parties, trois minuts.

De la même rotule jusqu' au commencement du flanc, trente parties, un minut, et demi.

De la même rotule jusqu' à la fin du talon de la jambe droite, vingt neuf parties, deux minuts, et demi.

Le pied de la fin du pouce jusqu' au col de la jambe, dix parties, un minut, et demi.

La plus grande hauteur du pied, six parties, un minut, et demi.

La largeur de tout l'os de la clavicule, au côté droit, quatorze parties, un minut.

Du même os de la clavicule jusqu' au demi-teton, dix parties, quatre minuts.

Entre un bout et l'autre des tetons, quinze parties, un minut, et demi.

Du commencement de l' humero jusqu' au cubit, vingt deux parties, un minut et demi.

Du cubit jusqu' au commencement de la main, quinze parties, un minut et demi.

La plus grande largeur de l' anti-bras, huit parties, deux minuts.

La plus grande largeur du bras, six parties, un minut, et demi.

La largeur du pouls du bras en face, cinq parties, et un minut.

La plus grande largeur du torse, prise un peu plus bas du commencement du torace, vingt deux parties, et quatre minuts.

La moindre largeur du torse, c' est à dire au commencement du flanc, dix neuf parties, trois minuts et demi.

La plus grande largeur des os ilei là ou les flancs sont plus dehors, vingt une parties, un minut, et demi.

La plus grande largeur d' une trocantera du femur à l' autre, vingt deux parties.

La plus grande largeur de la cuisse gauche, onze parties, un demi-minut.

La plus grande largeur du genou au niveau de la moitié de la rotule, six parties, quatre minuts.

La plus grande largeur de la jambe, sept parties, cinq minuts, et demi.

La plus grande largeur d' un malleole à l' autre, quatre parties, trois minuts.

La moindre largeur du pied, trois parties, et cinq minuts.

La plus grande largeur du pied, en face, six parties, quatre minuts, et demi.

De la derniere vertebre du col à tout l' os sacré, trente huit parties, quatre minuts.

De la fin de l' os sacré jusqu' à la fin des fesses, six parties, quatre minuts.

De la fin des fesses jusqu' au commencement des gemeaux quinze parties, quatre minuts.

Du commencement des gemeau jusqu' à la fin de la figure, trente parties, un minut, et demi.

END OF VOL. I.